INTER AVIA

Review of World Aviation

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Small Airfields

NACA : The Installations for U.S. Aeronautical Research

Armstrong Siddeley "Mamba" Turbine—Modern Personal Aircraft—Lockheed TF-80C

Customs-Free Airports—Air Travel Formalities

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Review of World Aviation

OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume III — May, 1948 — No. 5

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Cover page :

Russian "Omega" Helicopter

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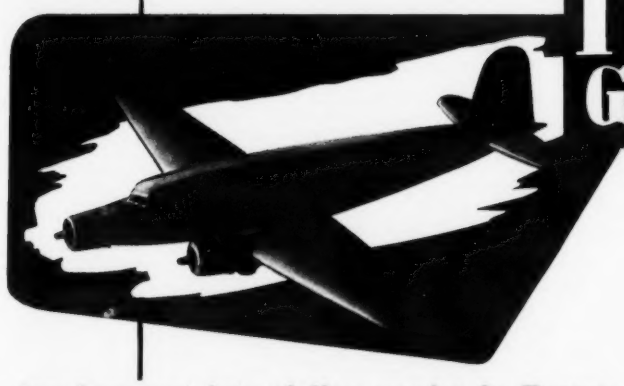

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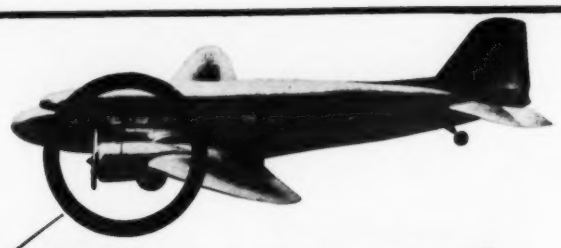

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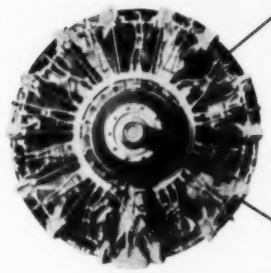

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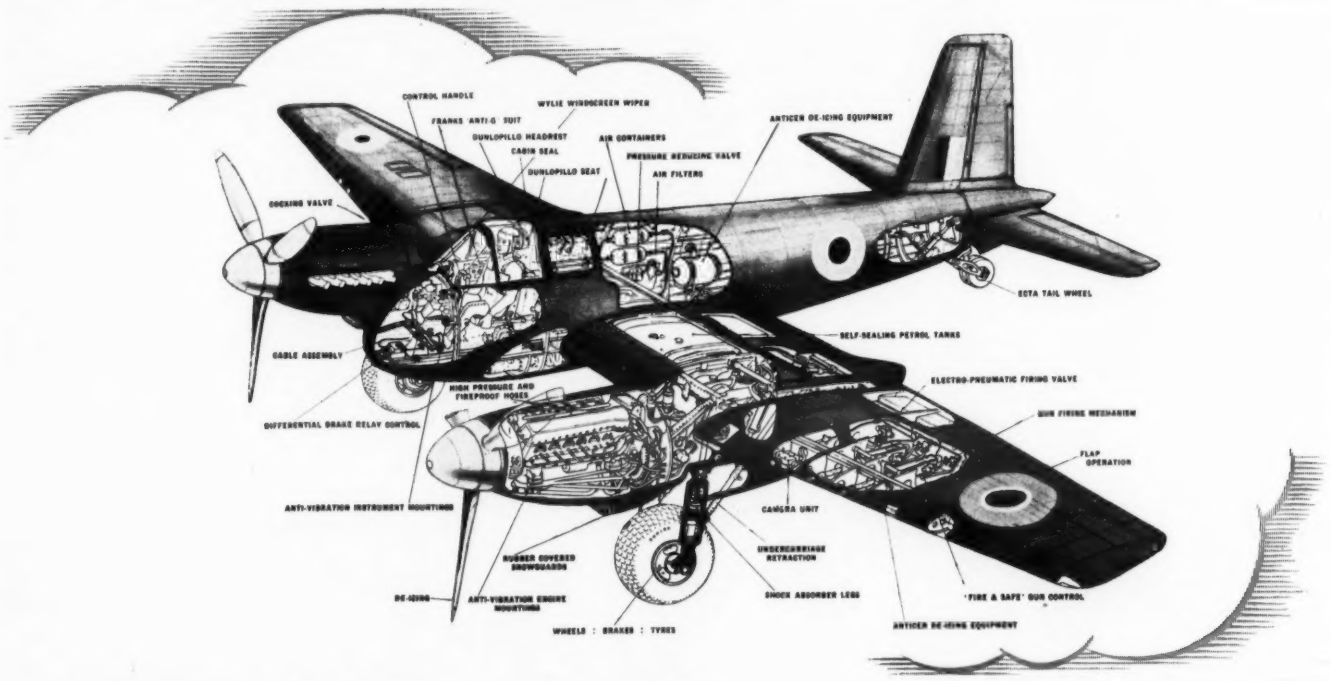

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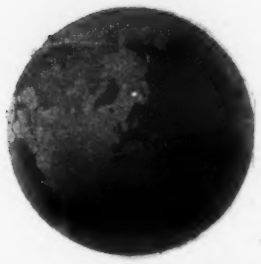


DISAPPOINTMENT WEEKS

Middle of April, 1948.

The legendary Ides of March have once again elapsed without our having seen U.S. citizens resident overseas, packing their bags, shipping their families back home, and again putting on their becoming khaki uniforms. The present mental picture is skilfully painted by the world-circulated U.S. weekly, "Colliers," of April 3rd: "... There's Too Much War Talk." — "... An impatient man here and there says war is inevitable, and we had best have it over without delay. But that is the lunatic minority, speaking irresponsibly and without authority. The majority, the overhelming majority, say no, we will do nothing to provoke war... We do not agree with [the Russians'] political, economic and religious views as Communists, but... we were on the same side... All we Americans can do is to retain our present will to do all that can be done reasonably and honorably to avoid provocation, to deal justly with Russia..."

This is the opinion of the average American, probably also of the average Russian, the average European and certainly of the average Chinaman. Let there be peace once and for all!

For the sake of peace, the British are endeavouring to tone down the air catastrophe over Berlin's Gatow airport on April 5th, 1948, although it is really a scandal that fourteen civil airline passengers should be slaughtered because of the imprudence of one fighter pilot. However, the incident is now a closed book.

Far more serious than the air collision over Berlin seems to be the unmourned burial of UNO's efforts to have atomic energy controlled. And despite this, the public was given much less to read about this than about the exchange of Notes between a furious Russian Marshal and a still angrier British General.

At the instigation of Great Britain—who at that time had no atomic weapons—the UNO Atomic Energy Commission met for the first time on June 14th, 1946. On March 29th, 1948, the British, French, Chinese and Canadian delegates stated that further discussions in this connection would be without purpose, and the U.S. delegate supported them on this count.

The situation was as follows. After they had dropped atom bombs on Hiroshima and Nagasaki, the Americans—like the Sorcerer's Apprentice—were suddenly scared of the very ghosts they themselves had evoked. They suggested to UNO that they should destroy their own plants for producing atomic weapons, renounce all further production of atomic weapons, and hand the entire nuclear fission process over for control by an ultra-State body which would be universal. And what was the Russian counter-proposal? Agreed, provided that State sovereignty remained unaffected by such a control.

Even for the naive Yankees, this counter-proposal was altogether too naive. How can a right to control be really effective if it has to stop at national frontiers? If you want to undertake a trip to the U.S.A., then, provided there is not a warrant out for your arrest, it is usually enough if you submit to having your fingerprints taken and swear an oath before the nearest U.S. Consul that you have no intention of assinating the President or fomenting a revolution in the U.S.A. Then the blessed land is opened to you and you can move about there as freely as you wish. Should you wish to travel about in Russia, then the whole affair is somewhat more involved. Who has ever been around the Urals, or in Siberia—at least as a tourist?

The plan for universal control of atomic energy is therefore up against a brick wall for the time being, and after two years have been spent in discussing the subject, research and development has continued at a merry pace.

Struth! This is much more disturbing that an exchange of Notes in the Berlin sector.

* * *

As if this were the only disappointment of the last few weeks!

Do you recall how Mr. Juan T. Trippe, President of Pan American World Airways, about three years ago promised confidently: everybody would fly the North Atlantic, everybody would be spending weekends in Paris or New York. The price of the ticket was to have gone down to $200, but on April 1st, 1948, it was increased from $325 to $350. That was one instance where Mr. Trippe tripped up.

But, as can be seen now, many industrialists made mistakes. With the Douglas DC-6, the highly-promising airliner, the manufacturers have so far not earned sacks of gold. In the case of the "Constellation," it is possible that Lockheed's, in view of the serial production, are just attaining a point where losses are no longer incurred. But Lockheed's have now definitely abandoned their twin-engined "Saturn" project. Glenn L. Martin's are reducing the scope of their civil activities by abandoning the pressurised Model 3-0-3 version of their new twin-engined transport. Republic Aviation have sacrificed around seven million dollars on the production of their famed "Seabee" light amphibian, and another sad story in itself would relate of their losses from the experiment with the four-engined "Rainbow" high-speed airliner. Cunliffe-Owen, who were trying to put their British twin-engined feeder on the market, have suspended all payments. And the British aircraft designer, F.G. Miles, who, ten years ago, was regarded as the "wonder baby" of the British aircraft manufacturing industry, has sacrificed his own fortune and that of his shareholders. It is only now that one can appreciate the incredible flair displayed by Rolls-Royce, Ltd., who, a few years ago, painlessly disposed of their holdings in Miles Aircraft. Now that we have given examples from the U.S.A. and Great Britain, we cannot remain silent about the fact that, in certain instances, the nationalised French aircraft industry is also living through hard periods. On the other hand, however, it seems as though a modest aircraft manufacturing industry is growing anew in Italy.

* * *

Let us not abandon all hope. Things can also pick up again. The Paris night club owners are prophesying a peak business period towards the end of the summer, when the first European plenary session of the United Nations Organisation takes place next September at the Palais Chaillot. Sight-seeing from the Eiffel Tower during the daytime and midnight oil-burning escapades in Montmartre afterwards. There is quite a story attached to Chaillot. Once in a rustic village on the outskirts of Paris, it is now the name given to a spacious building which was completely renovated for the 1937 World Fair. Unfortunately there also exists a comedy by Giraudoux which bears the now-inappropriate title of "La Folle de Chaillot"—The Crazy Lady from Chaillot—but let us make no "omens of nomens."

Perhaps that once it has been installed in the Palais Chaillot, UNO will finally become sane. Perhaps the Atomic Energy Control project will be attacked anew in Paris. Guns and swords in Montmartre? Such a thing is unthinkable—even for a Russian Marshal.

And then? Well things might gradually get better again. We might see all that ferrous drapery becoming a little more airy. We might also see a little more life in the civil aircraft manufacturing industry, and then Mr. Trippe would finally be able to start his cherished P.A.A. popular trips across the North Atlantic.

Why not?

E.E.H.

FIRST EXPERIMENTAL CATAPULT LAUNCHING of the North American FJ-1 "Fury" jet fighter from the deck of the aircraft carrier "Boxer," is watched by the tense crew. The cable of the hydraulic catapult is attached aft of the nose-wheel well. The breakaway loop of the restraining cable, holding the plane back until it has developed maximum thrust, has already snapped and in under two seconds the FJ-1 will have been whipped along the 90-foot catapult launch.

Small Airfields ?

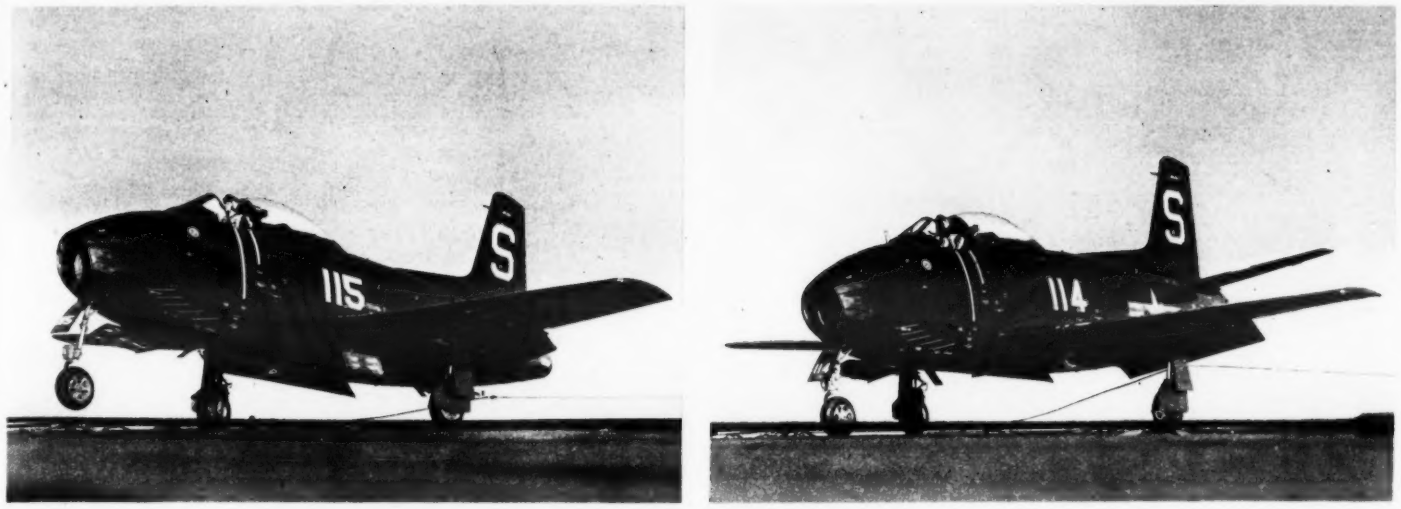
The Aircraft Carrier as Pattern

We have been used to watching airfields grow with flying speeds. Whereas before the outbreak of the last war runways of about 3,000 ft. length were altogether adequate, the war-dictated loading of transport aircraft called for increasingly longer take-off distances. And today we no longer speak of airfields with runways of 2,000 or 2,500 ft. length. In every instance runways are now being lengthened, and it is regarded as perfectly logical that new constructions should provide runways of at least 6,000 or 8,000 feet. The technical departments of the International Civil Aviation Organisation have worked out standards for the various classes of commercial airports and have decreed that for Class A airports, for example, the main runway should measure at least 8,400 ft. For scheduled civil air transport ICAO no longer counts on airfields with runways of less than 3,000 ft.— corresponding to an airfield of the lowest category, Class C.

To date, no means has been found for substantially reducing the take-off or landing runs of commercial transport aircraft. Increasing the take-off power of the engines and improving the effectiveness of lift-increasing mediums represent the only methods with which aircraft designers have so far attempted to cope with the augmentation of take-off and landing distances. True, attemps have also been made with more radical methods, at least as regards shortening take-off distances. In this connection mention should first be made of the American attempts with jet-type landing aids in the form of auxiliary rocket-power units. Quite apart from the present very high costs of these JATO take-off rockets, this method has found the enthusiasm neither of the airline companies nor of the travelling public. A similar situation exists as regards shortening landing runs. Even if no very serious consideration has been given to the possibility of shortening the latter distances with the help of rocket units, it must all the same be admitted that, apart from reversible-pitch airscrews, there exists as yet no means of giving effective support to the braking action of the wheels. Here, too, it must not be forgotten that aircraft may not be halted too suddenly after landing, this in the interest of the passengers' well-being.

The fact that the expansion of military air bases has proceeded along exactly the same

PREPARATIONS FOR A CATAPULT LAUNCHING demand smooth co-operation between crewmen. Pushing the plane up to the take-off spot and turning it to face the right direction must be a matter of seconds. Simultaneously, the catapult cable is connected to the hook behind the nose-wheel and the restraining cable attached with the breakaway loop to the tail. The catapult will be triggered as soon as the aircraft's turbine has attained full r.p.m.



THE ARRESTER HOOK HAS ENGAGED ONE OF THE TWELVE ARRESTING CABLES which span the deck just above the surface level and bring the plane to a halt a few yards after the touchdown. The pilot executes a partial flareout so as to engage the cable at the same time as the main wheels touch the deck. Only afterwards is the nose dropped to bring the nose-wheel down. Photographed from deck level, this picture shows the taut arresting cables as horizontal black streaks.

lines as that of commercial airports is surely above all because these bases have simultaneously to fulfil the requirements of military air transport fleets, without which present-day air forces cannot operate. Apart from this, meanwhile, the constantly increasing wing loading of military aircraft types represents another factor calling for correspondingly longer runways. Despite the enormous sums necessary for erecting military air bases, however, it looks as though a way has been found for coping with this situation—as gloomy as it all may be. To a certain extent, this may be warranted in countries whose flat expanses and topographical form enable all strategic and tactical demands to be taken into account. But when it concerns the erection of air bases in mountainous regions, or if for tactical reasons air bases have to be established at topographically unfavourable points—such cases usually concern air bases for interceptor fighters—it is probable that, in future, radically new airfield configurations will be absolutely unavoidable.

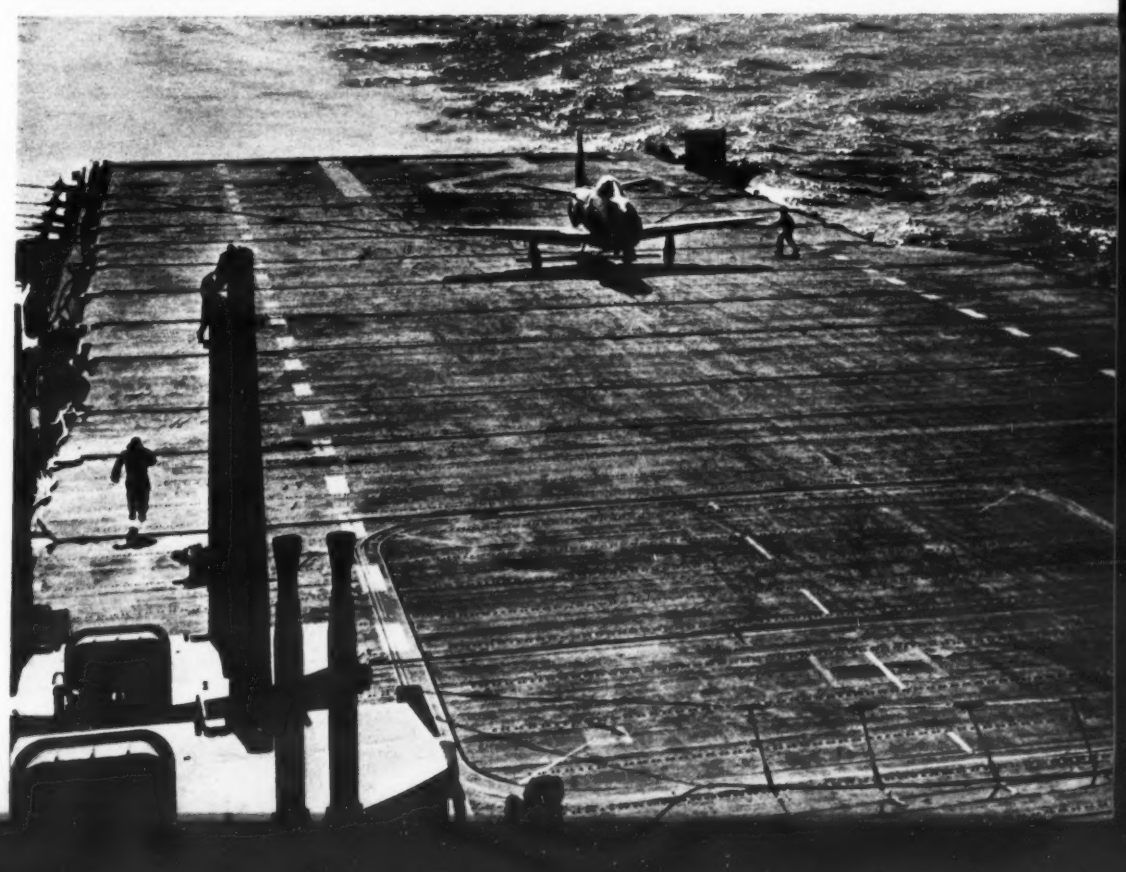
The design of these new airfields ? They do not represent inventions of today, neither are they to be regarded as over-imaginative technical projects. The operation of jet-fighters from aircraft carriers directly brought the airfield problem a step forward.

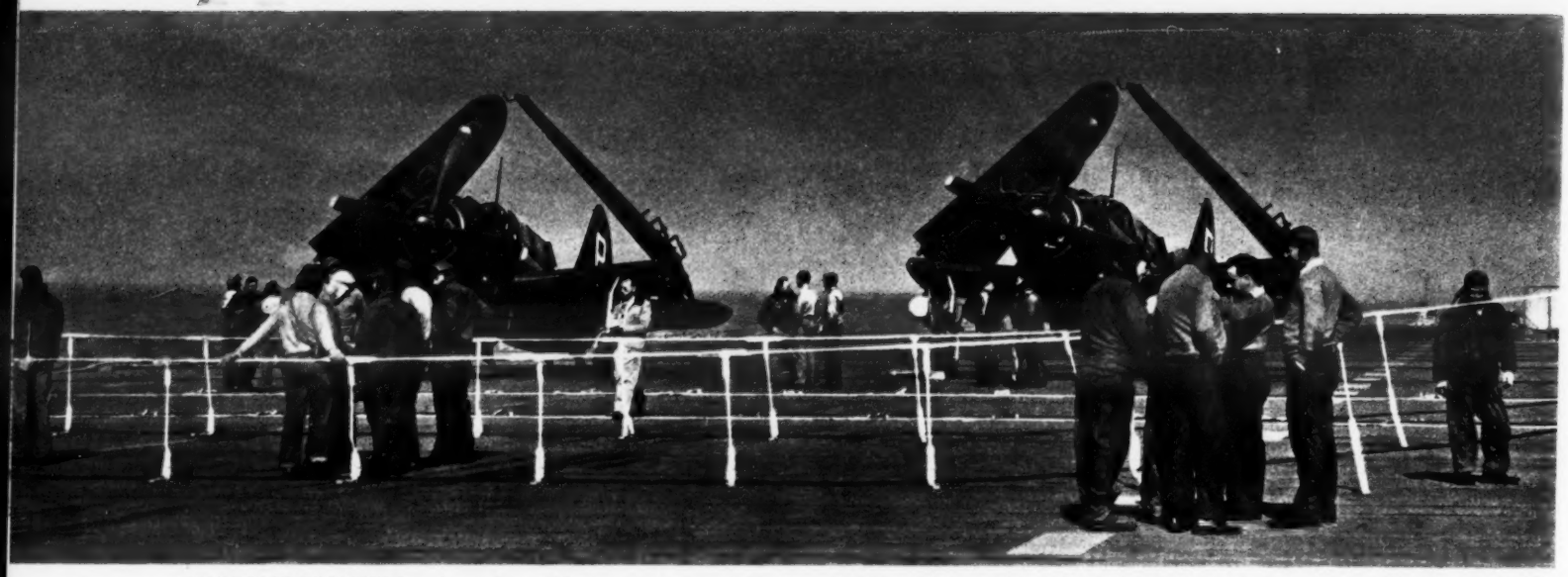
Already during the course of the past year attempts were made in Great Britain to land de Havilland "Vampires" on aircraft carriers, and recently similar experiments were carried out with the new Vickers "Attacker" jet fighter. The U. S. Navy also carried out similar tests with Lockheed P-80 and McDonnell "Phantom" jet-fighters. The primary object of these attempts was to assess, once and for all, the practical utility of jet fighters as carrier-borne aircraft. It was only during the course of last March that the first operational tests were made in this connection, when the new U. S. jet fighter, the North American FJ-1 "Fury", was thoroughly put through its paces on board the Essex-Class (25,000 tons) carrier, "Boxer."

Those days when naval aviation was content to operate, for better or for worse, fighter aircraft of which the performance, in the interest of shorter take-off and landing runs, was far inferior to that of landplanes, are over for good. Just as for any ordinary fighter aeroplane, carrier-borne fighters also have to possess a maximum speed of 600 m. p. h. or more, though provision is simultaneously made for a landing speed of about 100 m. p. h. The other demands made of carrier planes apply to every fighter, though perhaps to a slightly lesser extent : a good reserve of lift when approaching, for a wave-off in case of a misjudged landing, before the turbine engine can again rev up to maximum r. p. m. ; good low-speed control, such that a pilot, aided by the landing signal officer, can safely land his aircraft so as to engage between the first and fourth deck-arresting cables ; sufficient structural strength to withstand a powerful catapult launching and gain about 125 m. p. h. within two seconds after a 90-ft. catapult has been triggered ; best possible forward and down visibility.

On the 880-foot-long deck of the "Boxer" the FJ-1 jet-fighter revealed its ability to take off on its own power and become airborne after about 750 ft. The hydraulic catapult,

SPOT LANDING ! ARRESTING CABLE N° 1 HAS HALTED THE FJ-1, and deckhands are already hurrying to release the arrester hook and roll the plane away. The first row of auxiliary arrester devices is visible in the foreground. These only enter into function if for some reason the plane misses the main arrester cable.





THE DAVIS CRASH BARRIERS each comprise a white nylon cord spanned about three feet above deck level and connecting with frequent risers to a strong steel cable lying on the deck. If a nose-wheel catches the nylon rope, the risers lift the steel cable so that it may be engaged by the main landing wheels. In this way there is no risk of a smashed nose-wheel.

however, which can also be mounted on small-size aircraft carriers where space is restricted, also has other advantages. For launching a jet plane, the catapult cable is attached to a slip-hook located aft of the nose-wheel well, whereas a second cable, for restraining the aircraft, is fitted with a breakaway ring attached to a hook beneath the tail. To begin with, the turbine engine is revved up to maximum thrust and, subsequently, the catapult's hydraulic power is built up. As soon as the force of the catapult exceeds a certain value, the breakaway ring on the restraining cable snaps. In this way, against a deck wind of 40 m. p. h., the FJ-1 "Fury" was airborne 1.7 seconds after commencement of the catapulting action, *i. e.*, after release from the restraining cable.

The landing technique for jet fighters is different from that for airscrew-driven planes in one respect only. The straight-line approach distance must be longer, since the jet aircraft does not possess the braking effect of the airscrew and, besides this, requires more time to accelerate from idling speed to full thrust. The signal to "cut" is given to the approaching aircraft while it is at an altitude of about 35 feet above deck level, upon which the pilot reduces his engine speed to about 3,500 r. p. m., thus retaining a little less than 50 per cent. thrust. At this moment the pilot drops the nose and executes a last-minute partial flare-out so as to engage an arresting cable with the hydraulically-extended tail hook just as the main landing wheels touch the deck.

600 M. P. H. FOR MODERN CARRIER JET FIGHTERS. Thin wing sections are therefore essential, with the result that the entire fuel supply must be housed in the fuselage. The earlier folding-wing principle for naval fighters, in order to facilitate storage, will hardly be structurally possible in future. In consequence, the FJ-1 "Fury" employs a kneeling-nose device comprising a small dolly attached to the nose-wheel and coming into operation as the latter is retracted.

Since some provision must be made for a failure of the braking device, the U. S. Navy had developed a new auxiliary arresting apparatus for nose-wheel equipped aircraft. This is known as the Davis Crash Barrier, five of which are erected after the twelve arrester cables spanning the deck at regular intervals. Each consists of a nylon rope spanned at about three feet above the deck and connected by risers, spaced at frequent intervals, to a steel crash cable lying on the deck surface. The aircraft nose-wheel engages the nylon rope, causing the steel cable to be raised and caught by the main undercarriage. In this way there is no risk of the nose-wheel being smashed up by the landing impact.

Now that American experiments have proved the practical utility of such equipment for aircraft carriers, in principle it should be possible to use it for military air bases on land. Understandably, the land-based catapults and runways would have to feature somewhat larger dimensions than those mounted on aircraft carriers, as one would not be able to count on a constant deck wind. But it goes without saying that a reduction of the take-off and landing runs to about 650 ft., thanks to the provision with one or two catapult launches and the necessary arresting devices, can offer not only great technical advantages but also appreciable tactical gains over present-day large airfields. It would therefore not be too bad an idea if an earnest effort were made to transfer the equipment and operational experience from aircraft carriers to land bases. Though this procedure could not be used for civil air transport operations and large aircraft, it could all the same solve many problems as regards the establishment of fighter air bases. And, all taken into account, it would only mean the creation of a transitional stage between present fighter armament and the means of aerial warfare of the future.

Bi.

Convoy Cover

The episode described here is taken from the unpublished memoirs of a French fighter pilot. It does not tell of anything epical, or even particularly extraordinary, but simply of a mission which was not without its dangers and responsibilities.

February 7th, 1944, is a date I shall not easily forget. And I think my Squadron Commander has still better reasons for remembering this date as long as he lives. Those were times of obscure sacrifice, of thankless devotion, for which no laurels were conferred. I can vividly recall the hardiest missions of the campaign against Germany, but I cannot remember a single day on which I strained myself to the limits of human endurance as I did on that particular date. And yet nobody would have wished to risk looking ridiculous by composing a citation containing only this simple phrase :

> "In bad weather, and with dusk closing in, he protected a convoy off the coast of Africa."

I remember it as if it were yesterday. We were at "stand-by," strapped in our cockpits with our planes turned to face the runway, ready to take off the moment the signal was given. How many hours have I passed waiting to go into action during the course of the War ? Surely hundreds, and perhaps even thousands. In the ordinary course of events we used to read, write letters, sleep fully equipped beneath the wings of our planes, or else have long, heart-to-heart talks with a pal who had come to visit us.

On that day, however, twelve pair of eyes were glued to the watch tower, from where the rocket signals would be fired. Twelve hearts throbbed faster and faster with the thought that this might be the big moment, which would make up for all the hours we had wasted. Twelve engines were kept red hot, ready to deliver the last fraction of their power at a second's notice. We knew that an immense convoy was to pass off our shores, and that the Germans would take off from somewhere in the south of France to attack it.

Every fighter unit along the North African coast was on the *qui vive*. Our twelve pilots, forming the "Breezy" squadron, were not the only ones to stand guard. Our hearts were beating in unison with twelve of the "Scratchy" squadron at Oran, twelve of the "Baby" squadron at Algiers, and twelve of the "Tony" squadron at Philippeville. And hordes of British fighters were scheduled to invade the skies after sunset.

As fast as the sun went down, the ceiling dropped. And it was not long before fine rain was misting our windshields.

* * *

Two rockets shot over the tower, flashed for a moment, and fell graciously to earth. At the harsh sound of the alarm signal, twelve pilots leaned forward as one man, making the same precise gestures in perfect unison, and thirty seconds later, twelve propellers were whipping up a heavy spray. Then the first aeroplane, with the Squadron Commander at the controls, roared into the grey, rainy haze. Two minutes later all twelve machines were on the wing, hugging the low ceiling and fiercely churning their way into the menacing turbidness.

From the moment my wheels had left the runway, I was aware of Fear, and for two and a half hours Fear was to be a persistent and menacing companion to me. To all who are keen on adventure and mystery, my advice is to try a little bit of practical instrument flying. They will meet with supernatural fears which can take ahold of a man and threaten to destroy him.

Moulins' plane, leading our flight of six, was disappearing into the fog above, and I was nervously endeavouring to keep on his tail. The six planes led by the Squadron Commander were no longer visible, so that this phantom flight, which could easily collide with us at any moment, provided yet another menace. The din of the radio was infernal. The thirty-six planes of the "Scratchy," "Baby" and "Tony" squadrons had all taken off at the same signal as ourselves, and everybody was talking into the radio at the same time, so that what I heard in the earphones was a noise like a great crowd gone mad. The cries of pilots who had lost their way, asking for help and demanding a fix from their leader ; loud voicings of overstrung men whose nerves had got the better of them ; the usual witticisms of the "bright boys" who thought it absolutely necessary to tell

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everybody in the skies that they were not the least bit scared :

"Where the devil do you think course 300 is ? Why the hell don't you wind your compass up ?"

"Anything to please a lady, but it so happens I've lost the key."

"Well, if you come any closer you'll be able to take mine from my right-hand pocket !"

"For the love of Mike, put a sock in it !" came the exasperated cry from Ops.

Ops. was on edge too. Those few men in their underground shelter at O . . ., who had to control the evolutions of forty-eight planes containing pilots as blind as bats, were also responsible for the safety of a hundred-and-fifty ships.

Ops. gave course 300 to Moulins, and we crossed the coastline, almost grazing the sand dunes. The result was that we were literally face to face with a raging sea, which was carving out deep, green phosphorescent hollows beneath us, its long tentacles of spray snaking towards us as if they wanted to snatch us in flight and drag us down.

We struggled on through this vague limbo between a sea and a sky which merged confusedly into a shapeless, terrifying mass, without height, depth, width, or end.

"Hullo Breezy Red Leader ! Augustus to port," a voice cried out.

"Breezy Red Leader. O. K., seen it."

Augustus was the convoy, "Breezy Red Leader" was our Flight Commander, Moulins. As Moulins went into a tight curve I began to perceive, semi-shrouded by spume, the rain and the fog, two cruisers tearing along furiously, their smoke mingling with the murky ceiling. Then I could see ten, twenty, . . . countless phantom vessels which seemed to be floating in the same grey nothingness as ourselves. As we dropped to fly a few feet above one of them, we could plainly see black, shiny sou'westers moving busily across the decks, deluged by waves as the ship keeled over almost vertically.

I shall never be able to rid my mind of that phantasmagoria, that fleet of ghost ships breaking the frightening monotony of infinite grey void.

It was not long before everybody radioed Ops. that "he was over Augustus." First "Breezy," then "Baby," then "Tony," and finally "Scratchy." But we pilots could not see each other. We were all scattered somewhere between the greyness and the waves, hovering above the immense convoy which stretched for over twenty miles beneath us. From the thickness and length of the wakes, we knew that the convoy was forcing its pace. Every two minutes the wakes would be jumbled up as the convoy changed its course to elude enemy U-boats. We radioed Augustus, but he kept silent — a sign that the enemy was approaching and any signal they broadcast could give away the convoy's position.

* * *

As it always happens, pandemonium broke lose with incredible suddenness.

" Hell ! " an anonymous voice yelled. "There's a Junkers right below me."

He was so excited that he forgot to signal who he was and where he was. The result was that forty-seven planes broke formation and forty-seven pilots started howling into the mike for an explanation. Once comparative silence had been re-established, we heard :

"Pierrot here ! I've lost track of him."

He was one of the "Baby" squadron — the dumbest of the lot, but they had all the luck. The Junkers were there all right, flying in our midst, but we couldn't manage to distinguish them properly. It was a new sensation, for now we couldn't make out whether we were the hunters or the hunted.

The Jerries must have skimmed the waves to get there and the radar look-outs on the coast must not have been able to catch them owing to the filthy weather. Ops., blind and confused, asked the pilots for information, but in vain. I was present at an invisible drama, and I knew I might be assigned the main rôle at any second. It was comforting to see that the ships continued to plough forward obstinately, as if nothing had happened.

Suddenly the sea seemed to be transformed into a wall of flame. From every deck of the hundred-and-fifty ships, red and orange tracers shot skywards, to become enveloped in the grey heavens. The escort cruisers swung over madly, obscuring themselves in flame-specked smoke. Here and there immense columns of water mounted up dizzily, like monstrous mushrooms, and folded back again into their own spume. The Junkers were attacking, but we still couldn't see a thing. Moulins immediately made for the north of the convoy to intercept the attackers, but they were so well hidden by the smoke-laden fog that it was madness to hope that we could ever spot them.

Right in the centre of the convoy, through the sickly, sulphourous gloaming, a brief but enormous flash rent the atmosphere. It was a ship loaded with ammunition that had exploded. We knew that we would later find corpses washed up on the shore, bits of wreckage spewed up by the sea. We turned back, powerless and furious, struggling to see our way through that vague magma, devoid of all depth and dimension.

Just below me I made out a sort of grey, fleeting shadow heading in the direction of the convoy, as vague and illusive as a fish at the bottom of a muddy pool. It was a Junkers ! I peeled off, wildly shouting a warning to Moulins, but the suddenness of my manoeuvre caused me to lose this faint trace, and I barely had time to pull out before being swamped by the raging waves. I found myself alone. I had lost both Moulins and my ghostly foe.

"Hullo !" Moulins shouted back to me. "I'm on the tail of one of them. Steering course 25."

Futilely, I followed his indication, battling my way through the shadows that seemed to get thicker from minute to minute. The din from the radio was unbearable. Forty-eight lost pilots were looking for each other, screaming orders and warnings. Ops., snowed under with requests, had given up all hope of making itself heard, and refused to take any further part in the Satanic concert. I was racking my brains. How long had I been flying ? I hadn't the faintest idea. All I knew was that I was lost at some point about sixty miles from the coast. The night was creeping slowly through the fog banks, casting a terrifying coat of blackness over the entire scene.

At the very second when panic was about to take a hold of me, ready to tie my nerves into knots, I heard a voice crying out for help :

"This is the Squadron Commander. My engine's packing up. I'm baling out."

It so happened that we had been flying with rotten engines for about six months. And every time they packed up, you could be sure you would be at some spot well out at sea. Most of us had already made the acquaintance of our dinghies, the little pneumatic boats we carried in our parachutes. We were truly obsessed by our engines, which we knew could let us down at any second.

"It's odd that the lower one flies and the further one is from the coast, the more these damned engines vibrate," the Commander used to say.

He was perfectly right.

The Commander's S.O.S. had hardly died down before my own engine started to vibrate. Through the regular noise I could discern an unusual sound which seemed to echo like a funeral bell, and the idea of the possible consequences sent shudders down my spine. I started thinking of the Squadron Commander suspended from his flimsy parachute above the hungry waves. Would he have time to float his dinghy and get inside it ? I was picturing him as a tiny speck being tossed about by that awful sea, wedging himself in his frail craft of yellow rubber. I could hear the chaps of the first squadron trying to contact Ops. for a fix so as to locate the spot where he had baled out, but the din of the radio had become so deafening that Ops. told them to shut up. The British night-fighters had already filled the skies and their clipped, high-pitched voices echoed over the entire network. Everybody forgot the Commander, and his fate went unheeded amid this mad inferno.

A new fear assailed me : fifty night-fighters had already filled the sector, and they would spot me. If ever my special I.F.F. warning apparatus refused to work, they would take me for an enemy and shoot me down.

The night had become so black that it was impossible to see my own propeller. I switched

on the dashboard lamps, and my instruments gave forth feeble green lights like glow-worms. A whole constellation of needles, dials and numbers from which, like some mad astrologer, I had to read my destiny. I dared not seek altitude because of the icing levels prevailing. My life depended on keeping the little needle of my altimeter between 100 and 500 ft. The slightest nervous gesture, a fraction of a second of inattention, and I knew that my plane would pass the limits of that narrow strip of space in which I was flying, as blind as a bat, at 250 miles an hour.

I began to conjure up images of either a brutal smash-up, destroying and scattering me and my machine, or the fatal effect of ice which piles up on an aeroplane, weighs it down, blocking the controls, and finally causes it to plummet to annihilation.

I was making for where I believed the coast to be when fiery serpents, red and orange, started flashing across the blackness of my windshield, surrounding and following me. It was the convoy shooting at me. Could it be that my I.F.F. warning device wasn't working ? I rather think that the convoy was a little nervous and that, as a matter of principle, a convoy which has just lost a few ships hates to be flown over, whether by a friend or an enemy. I can't believe that those gunners were really serious. They were probably trying to warn me to move on, for if they had really meant business, I don't suppose I'd be here to tell this story.

Oddly enough, their firing turned out to be providential for me, as I could then work out an approximate position. I tried to remember the courses we had taken, the times and the orbits, but my brain refused to function and the figures danced in such mad confusion that I finally gave up the idea. Only, I was certain of one thing—that I was near to the coast, near enough to pile up against the cliffs. I endeavoured to locate the beacon over our base, which would be flashing the letter "D," but nothing penetrated the darkness.

My fuel was giving out, and I decided to try for altitude despite the icing level. If I iced up . . . well, I iced up . . . and that was that.

Ice-up or smash-up ! I mentally flipped a coin and decided that I'd rather be iced up.

Happily, the level was not very thick, and my plane soon pierced it. I found myself beneath a canopy of jet black sky, with a huge moon casting her cold, cruel light over the white blanket beneath me. Still today that vision, unique as it was, remains a precious memory, for few pilots have seen this dazzling and awful sight. At the time, however, that excursion into forbidden domains had no great charm, for I was very perturbed by the relentless descent of my fuel-gauge needles. In the earphones I could hear the deafening row of planes arriving at their bases. I had given up trying to make myself heard. Before attempting to descend, I decided to wait until the sector and the runways had become less engaged, and I took the southerly course so that I could eventually bale out over land if I were driven to this sad extreme.

The radio began to clear a little, and the radar stations were slowly getting their breath back. I heard the "Breezy," the "Scratchy," the "Tony" and the "Baby" aircraft landing one by one, and knew I was one of the last in the air. I called Ops., who fixed me at the latitude of Orléansville and instructed me to drop down to at least 1,500 feet, as I would not be able to see anything above that altitude.

Once again I was lost in the darkness, and my life depended on the needle of my altimeter. When it had attained 1,500 feet, I flattened out. I knew that I was below the cloud level, but still I could not see a thing. Ops. fixed my position again and gave me a course which would lead me to base. I followed it. A little later Ops. radioed that I ought to be able to see the beacon to port, but the darkness remained unbroken. I dropped slightly, and suddenly, very far to port, an almost imperceptible light flashed feebly. I started counting—one dash, two dots. It was our beacon. Weak as it was, that signal gave me new strength, for it meant that I had returned safe and sound.

My pals were out on the field, waiting for me, still wearing their putty-coloured Mae Wests. They, too, were still wondering whether they were really alive after those nerve-racking hours. Their haggard faces plainly showed the strain they had suffered, but, tired as they were, they were as happy as sandboys.

I lighted a cigarette, smoking it slowly, almost voluptuously. It was good to be alive.

* * *

"The Squad. Commander hasn't got back," Moulins told me.

"I know. I heard."

The Ops. chief informed us that the English night-fighters had already left with rocket flares for the point where we thought he had baled out.

It was a real comfort to us to know that such a great effort was being made to find our Commander.

We climbed into a jeep and went to the hut where several pilots were working on the Commander's case. They were re-plotting out the courses we had taken, and trying to assemble some information which might be useful to the Allied planes in their difficult task of spotting a tiny yellow dinghy somewhere on that vast expanse of water. Moulins yawned.

"I'm turning in. They're bound to find him," he said.

By dawn the weather had lifted, and light patrols of two planes began taking off to make a survey of the sectors Ops. had assigned them.

Around ten o'clock a "Baby" patrol announced it had seen a dinghy. A man was inside it, but he seemed inert. Ops. fixed the position of the patrol and re-broadcast it to every other aircraft. All the groups organised a permanent guard around the Commander, carefully keeping him in sight until a British high-speed launch could get out to him.

I dropped very low. The Commander was wedged at the bottom of his tiny craft, and was as still as a corpse.

* * *

To tell you the truth, Commander, you didn't look at all like the Big White Chief.

Incidentally, there's another little item which I remember—so insignificant that I shan't mention it to the Commander. By evening he looked quite different, and the next morning, at five o'clock, he was off on another mission.

The Air Hostess Told Us ...

FLYING FARM HANDS...

Esmeralda's rest cure—she's been on holiday for some weeks—does not seem to have done her much good. In fact, our Favourite Air Hostess was still in a pensive mood when we saw her in the middle of April. She told us the world was as wacky as ever. She had gone to the land of the "bel canto" and found it full of flying saucers, although they should have died out months ago. Someone told her somebody else had seen two of them flying over Alpengo on March 6th. A group of villagers saw lots of them surrounded by halos, operating at 14,000 ft. over Carrara on March 24th. And the villagers of Porretta Terme saw and *heard*—the things "made deep sounds" this time—a squadron of seven flying discs on the 29th. Esmeralda says she is sure they are connected with the Italian elections, on which the world's fate and everybody's happiness seems to hinge at the moment.

The flying saucers seem to be concentrating on "villagers" these days. Apparently they have gone rural. So has the rest of aeronautics. For example, a farmer in Peoria, Illinois, discovered that his pet prize hog got tired from being driven ten hours in a truck to the national pig show. He hired a Ryan "Navion" four-seater aircraft and the brute was flown there in a fifth of the time. Occupying the entire passenger space, Cuthbert the hog emitted a deep grunt at 8,000 ft. and went to sleep. Like so many other pigs do in passenger space, Esmeralda says.

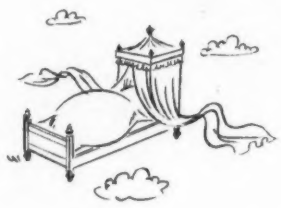
But pigs apart, the flying farm hand is here to stay. In California and Texas there are about 300 outfits spraying insect poison and weed-killers from the air on to tomato crops and vineyards. The same companies undertake the sowing of rice-fields in California and the reseeding of burned forests in Oregon. The Russians have decided to spread fertilizer over thousands of acres in the Don Valley, in the Rostov and Voroshilovgrad regions. The Americans are following suit. Since only "new-look" type aircraft, meaning the weirdest-looking kites, biplanes with struts and braces, corset-laces and built-in headwinds, are used for these missions, Esmeralda wonders why the fertilising Johnnies haven't hit on the idea of simply strapping an old cow to the bellies of their flying jalopies before setting out on their day's work.

THE IMPORTANCE OF TACT...

Esmeralda recently spent three days attending classes, learning the routine for the new sleeper aircraft on the Atlantic. You see, she works for one of those companies who have decided that passengers are much easier to handle when they are asleep. Anyway, a whole bunch of hostesses were training very hard, and they all expected to be past-masters in putting their charges to bed when the new aircraft finally got into service in May.

The hostesses soon found out that those berths were quite a problem. One berth is made up of two seats and costs about one hundred dollars a trip. Reservations are not to be made ahead of time but only on boarding the aircraft or even in flight. This fact offers various possibilities, including a black market in berths. A shrewd type could book five or six of them after getting aboard and subsequently rent them out to dog-tired fellow-travellers on a time basis. A much more touchy question, concerning which the instructor provided no solution, arose out of the fact that two people may use one berth for the same price. Should an air hostess, in view of the interesting friendships that sometimes develop in flight, endeavour to give the best service at all times or play the rôle of house mother and see that everything is very, very conventional ?

Which inevitably reminds us of the early years of the airline business when the operating companies were offering every kind of inducement to get people to travel by air. One day they hit on the stunt of giving each man who bought a ticket a round trip free for his wife. This was very fine and business was picking up at an astounding rate in a short time. Unfortunately, the public relations department of one of the airlines got the bright idea of writing a letter to each wife whose name they had received as accompanying her husband on such a trip. Very politely the clever boys of Public Relations enquired how the lady had enjoyed the flight and would she — now that she knew how safe and comfortable air travel was — let her husband fly again ? The whole project of granting such flights was hurriedly dropped, however, after Public Relations had received very numerous letters from angry wives who indignantly pointed out that on the dates in question they had never set foot out of their houses . . . *Bl.*



NACA

THE LANGLEY MEMORIAL AERONAUTICAL LABORATORY, at Hampton, Virginia, housed all NACA's research facilities up to the War. This photo shows the west area, as seen from the air.

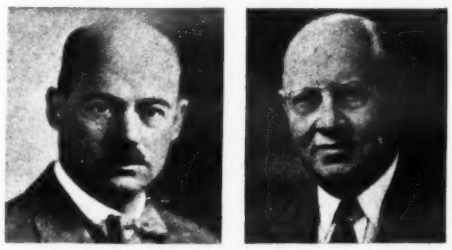
BY WILLIAM WINTER, CORNWALL BRIDGE, CONN.

On February 24, 1947, President Harry S. Truman transmitted to the Congress of the United States the 32nd Annual Report of the National Advisory Committee for Aeronautics, or "NACA." Unlike the new 33rd Annual Report, which is preoccupied with the technological revolution of jet and rocket propulsion, and supersonics, the earlier report was highly significant in that it marked the end of an era, and filled in the gap of the six war years.

These annual reports are submitted first to the President by the Chairman of the NACA, in accordance with the Act of March 3, 1915, which established the Committee to "supervise and direct the scientific study of the problems of flight with a view to their practical solution."

"The close of the War," wrote Chairman Jerome C. Hunsaker in the 32nd Annual Report, "marked the end of a whole phase of development of the airplane as conceived by the Wright brothers. The airplane in its present form is no longer a sound basis for future planning for the national defence. The power available in jet propulsion systems brings flight through and above the speed of sound within reach. We now see no definite limit to the power that may become available for jet propulsion. Nor do we see a definite limit to the speed that may be obtainable."

Even as this report painted new vistas for research and development, it recognized a number of grave difficulties. During the War the future had been sacrificed to the present. The perfection of existing airplane types necessarily supplanted fundamental research. Through Selective Service, scientists, engineers and technicians had been taken from the laboratories and industry, and scientific manpower suffered through the slowing-down of advanced education. And, by war's end, reserves of technical knowledge had been virtually exhausted. This bleak situation accentuated Hunsaker's concluding remarks. "The attainment of practical flight at such speeds," he wrote, "requires the application of new knowledge, which must be obtained by diligent research with new tools and methods. As with the Wright brothers, we stand at a new frontier..."



DR. JEROME C. HUNSAKER (left), now Chairman of NACA. DR. GEORGE W. LEWIS (right), Research Consultant and, up to 1947, Director of Aeronautical Research, NACA, has contributed notably toward the development of the research facilities since 1919.

It seems important here to differentiate between "new tools and methods" and research facilities, for, under wartime secrecy, the facilities were located at the Langley Memorial Aeronautical Laboratory, in Virginia. In 1940, the Ames Aeronautical Laboratory was begun at Moffett Field, in California, its purpose being to extend research to higher speeds and larger scale, in a location less limited by space considerations and electric power supply than the crowded area at Langley Field. By 1942 the initial construction of the Aircraft Engine Research Laboratory (since the advent of jet and rocket propulsion, known as the Flight Propulsion Research Laboratory) at Cleveland, Ohio, was in operation. In all, some 5,000 people were employed by V-J day. More recently, a station was established at Wallop's Island, Virginia, for the flight testing of models at transonic and supersonic speeds, and a second station was set up at Muroc Lake, California, for flight research on transonic aircraft.

The detailed over-all view of NACA equipment and activities is sufficiently overwhelming to require some special organization of an article for clear perspective. Accordingly,

WIND TUNNEL AND LABORATORIES in the east area at Langley Field.

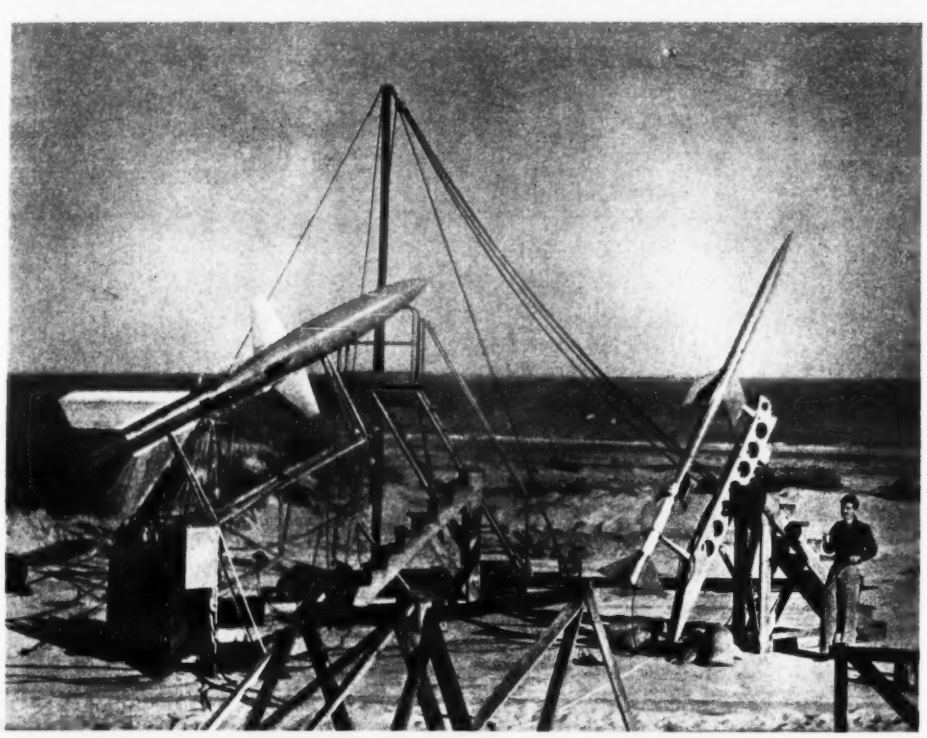
PILOTLESS AIRCRAFT RESEARCH STATION at Wallop's Island, Virginia, where NACA conducts experiments in the guided-missile field.

we have divided this material into parts : the present Part 1 deals with the history and organization of NACA and the Langley Memorial Aeronautical Laboratory ; Part 2, to follow next month, will be devoted to the Flight Propulsion Research Laboratory, at Cleveland, Ohio, and the Ames Aeronautical Laboratory, Moffet Field.

History and Organization.

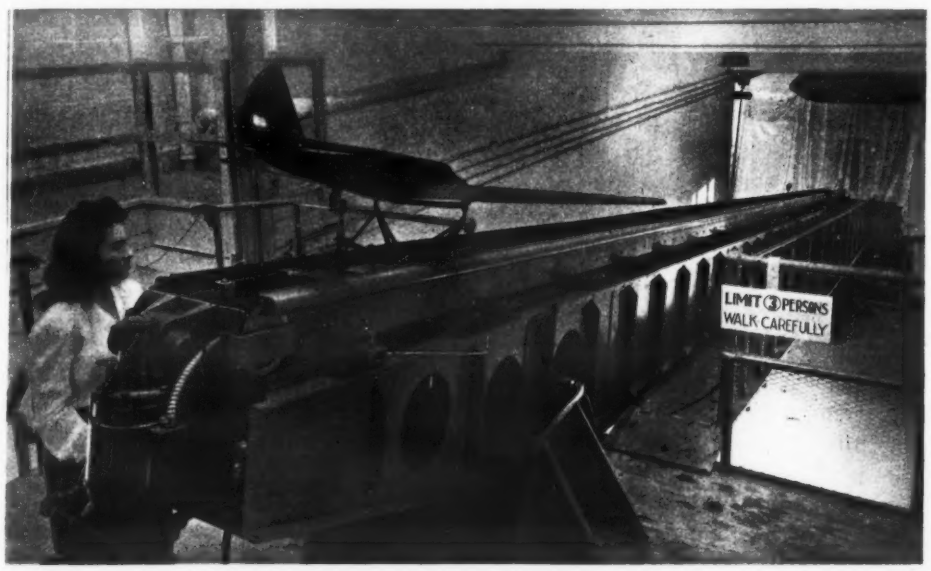
In the days of the Wrights, aeronautical research and development was a matter of individual contribution. By 1915, however, the airplane held such obvious implications that Congress recognized the increasing need of organized scientific research ; and in March of that year, passed an Act which established the NACA. To supervise and direct the scientific study of flight, the NACA was authorized "to direct and conduct research and experiment in aeronautics" in laboratories placed under its direction. The first laboratory organized was the historic Langley Memorial Aeronautical Laboratory. Since its birth in 1916, Langley has been expanded and modernized steadily until, today, it is the largest of all NACA facilities, comprising, at last count, twenty-three wind tunnels of assorted shapes and purposes, three seaplane towing basins, and thirteen specialized laboratories.

As originally visualized, the Committee consisted of twelve prominent men appointed by the President, but under an Act of March 2, 1929, this was increased to fifteen members, including two each from the War and Navy Departments' offices in charge of military and naval aeronautics, two from the Civil Aeronautics Authority, one each from the Smithsonian Institution, the United States Weather Bureau, and the National Bureau of Standards. The remaining six persons are appointed on a basis of their acquaintanceship with the needs



INVESTIGATING LOADS ON AIRPLANES

THE GUST TUNNEL enables strains on airplanes in gusty air to be ascertained. Models of about six-foot span are catapulted



FOR MEASURING THE STRAIN ON SEAPLANE FLOATS the Langley Laboratory has a 360-foot-long impact tank with a wave-making machine. The float is attached to a towing carriage running along rails in the roof of the laboratory, and is lowered rapidly to simulate a water landing. The forces acting on the float's planing bottom and suspension rig are measured.

of aeronautical science, either civil or military, or their skill in aeronautical engineering or allied sciences. These six serve for terms of five years, the others for indefinite periods. All work without compensation. (A recommendation has been made to Congress that NACA be permitted to pay not more than $15,000 to each of fifteen positions on its staff.) In line with the admitted increasing dependency of military aeronautics on fundamental research, the Committee recommended to Congress that Committee membership be expanded from fifteen to seventeen, the two additions being scientists who could strengthen the deliberations of the Committee, assume scientific leadership, and act as heads of major technical committees.

Preparing and recommending programmes of research in their respective fields, is a system of technical committees and sub-committees. At the moment there are six technical committees : Aerodynamics, Power Plants, Aircraft Construction, Operating Problems, Self-Propelled Guided Missiles, and an Industry Consulting Committee. Under those six headings are aligned some twenty sub-committees, the nature and number of which changes from year to year in keeping abreast of the times and their problems. Approximately three hundred of the nation's leading authorities in their fields hold membership on these committees and sub-committees.

If the complex activities of the NACA are boiled down, six basic responsibilities stand out. These are :

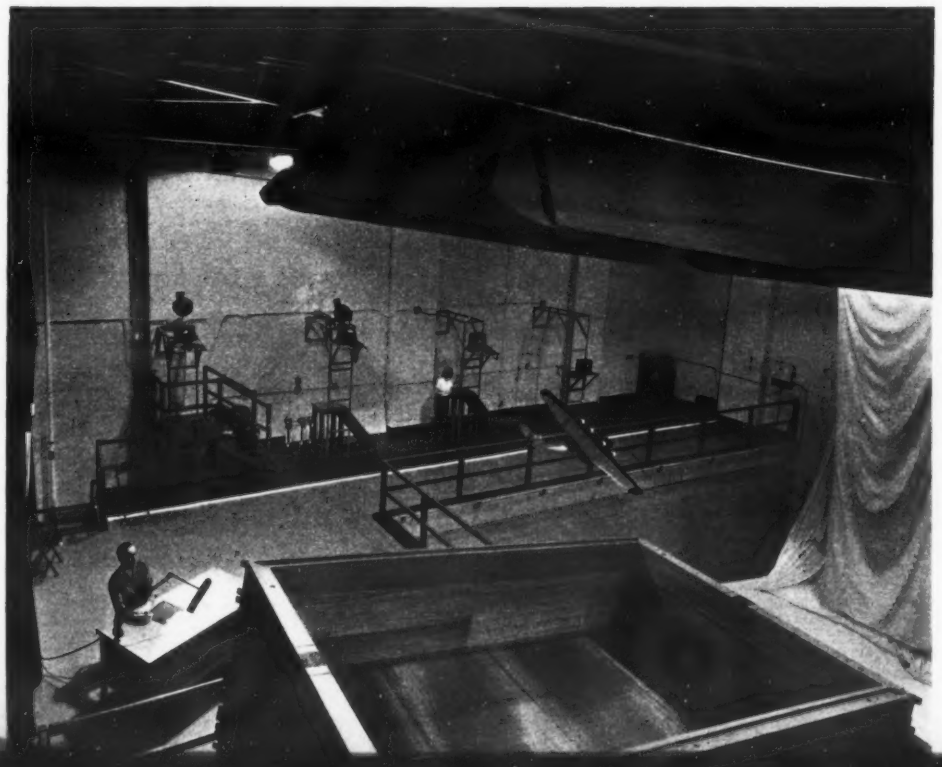
1. to forecast the trend of aeronautical development, civil and military ;
2. to anticipate the research problems that will arise ;
3. to design and provide the special research facilities necessary for solving the problems ;
4. to co-ordinate the fundamental research programmes of the government ;
5. to conduct fundamental and scientific investigation in its own laboratories ;
6. to encourage and support research in scientific and educational institutions.

Collecting, classifying, and disseminating technical knowledge, including the results of research and experimental work conducted in all parts of the world, is the task of the Office of Aeronautical Intelligence, established in 1918 as an integral branch of the Committee's activities. An Aeronautical Patents and Design Board, founded in accordance with an Act of July 2, 1926, was authorized, upon favourable recommendation of the Committee, "to determine whether the use of the design by the government is desirable or necessary, and evaluate the design and fix its worth to the United States..." Under the Act of March 3, 1927, the NACA analyzes and reports on the technical merits of aeronautical inventions and designs submitted to any agency of the government. In 1940, the Secretary of Commerce established the National Inventors' Council as a clearing house for government agencies and, since then, the Patents and Design Board has been dormant.

To guide its fundamental research towards objectives of optimum value in meeting the needs of industry for information, the NACA established the Industry Consulting Committee, mentioned above. Problems to be investigated are assigned on a broad basis. Most, of course, are given to the Committee's three laboratories. Some, however, are given to government agencies, such as the National Bureau of Standards or the Forest Products Laboratory, and by contract to scientific and educational institutions. In a sense, the broad scientific approach by coordinated groups of the Services, industry, institutions and the NACA, is about as essential to the early solution of the problems of high-speed flight and guided missiles as was the massive nation-wide programme for perfecting the atom bomb.

When the need for additional facilities for high-speed and large-scale research became acute, the Ames Laboratory, the second NACA research centre to be activated, was established in 1939. Construction was begun on February 21, 1940, and the first structure, the Flight Research Building, was completed August 7 of the same year. Ames' first tunnel went into operation on August 16, 1941. Including what is believed to be the world's largest tunnel, a 40 × 80 foot monster, Ames has in operation nine wind tunnels. Inasmuch as the construction of the Ames facilities coincided with the war effort, virtually all of its work was directed toward immediate problems of

(left-hand photo) at speeds up to 100 m.p.h. over vertical gusts (right-hand photo), and their behaviour is observed. The velocity and location of the vertical gusts can be controlled according to desire, so that they act on one wing tip only, for instance.



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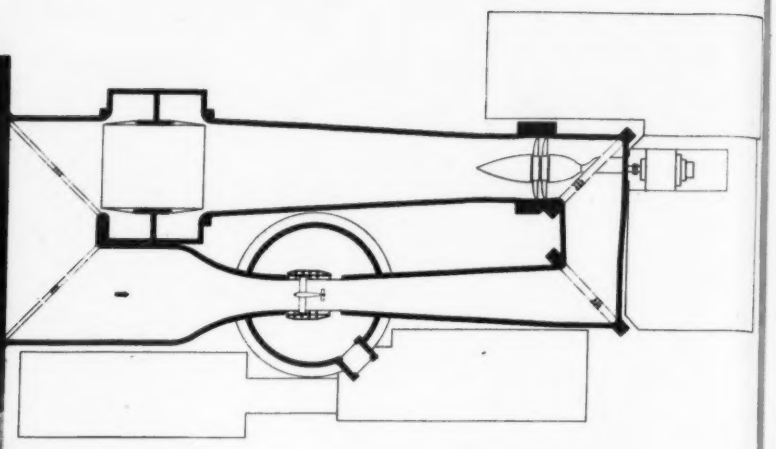


RESEARCH ON COMPRESSIBILITY EFFECTS AT HIGH SPEEDS

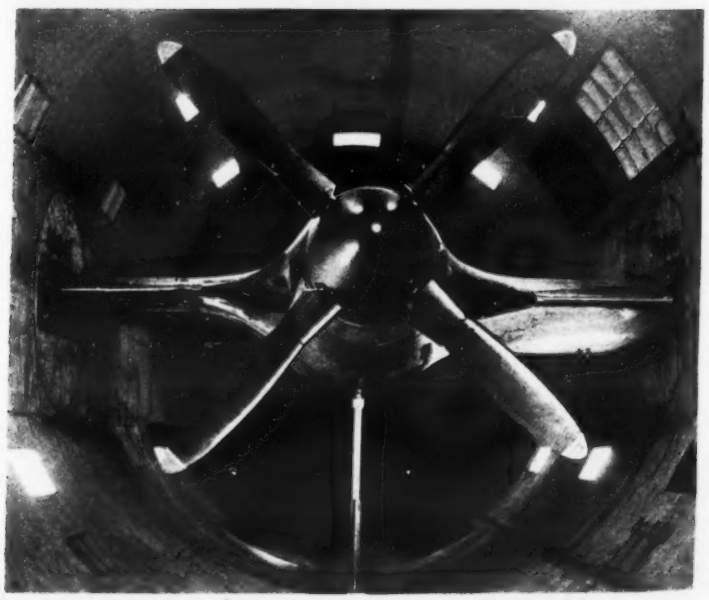
HIGH-SPEED WIND TUNNEL for speeds up to about 760 m.p.h. (sonic speed) to investigate shock waves, which result from the compressibility of the air and disturb the flow. The working space inside the dome is at a reduced pressure, simulating at full speed an altitude of about 18,000 feet; at this point the air stream has a diameter of eight feet.

PROPELLER INSTALLATION in the eight-foot high-speed wind tunnel. The 36-blade, 16-foot-diameter propeller is driven by a 16,000-horsepower motor.

that specific nature, and it was only after the War that the emphasis was shifted to fundamental research.

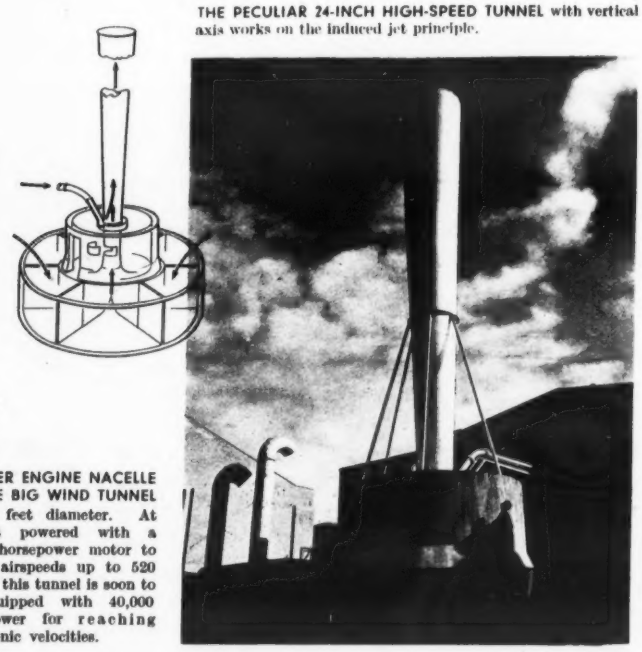
Lagging about a year behind the Ames Laboratory, the 200-acre Flight Propulsion Research Laboratory was begun at Cleveland, Ohio, in January, 1941, and the first research work started in May of the following year. The function of this laboratory is to provide basic information that can be utilized by designers and manufacturers to develop power plants of maximum performance, safety, and dependability. Being completed, as it were, at the end of the "Wright era," the Flight Propulsion Research Laboratory inevitably straddled the clear line of demarcation that separates the subsonic from the transonic and supersonic fields. With the coming of peace, these facilities were being converted to the study of turbines, rockets, and ramjets, as well as piston power plants.

Since June, 1941, NACA has been increasingly active in the guided-missile field. At the time of the 32nd Annual Report, eighteen specific guided-missile projects had been undertaken for the Services and the National Defence Research Council (NDRC). At present, research is going forward in these phases: rocket fuels



FIGHTER ENGINE NACELLE IN THE BIG WIND TUNNEL of 16 feet diameter. At present powered with a 16,000-horsepower motor to attain airspeeds up to 520 m.p.h., this tunnel is soon to be equipped with 40,000 horsepower for reaching supersonic velocities.

THE PECULIAR 24-INCH HIGH-SPEED TUNNEL with vertical axis works on the induced jet principle.



LARGE-SCALE WIND-TUNNEL TESTS

THE PRESSURE TUNNEL has a diameter of "only" 19 feet, but can give exact results for much larger airplanes. The errors arising from the utilization of a small-scale model instead of the full-scale airplane are eliminated by raising the air pressure—in the present case to 2 ½ atmospheres.

and combustion ; turbojets, ramjets, and "other forms" of power plant ; aerodynamics of wings, bodies, and control surfaces for all configurations of interest ; dynamics of controlled flight, including stability and requirements of servo-control mechanisms to operate controls. The original purpose of this Special Committee on Self-Propelled Guided Missiles, that of co-ordinating and recommending NACA research, has been fulfilled and this committee will be dissolved.

Langley Memorial Aeronautical Laboratory.

With the single exception of aircraft engines, this laboratory covers every phase of aeronautics. The impedimenta of Langley's many-fronted war on the aeronautical unknown is a spectacle that profoundly impresses the privileged visitor. The truth of the matter is that Langley's laboratories would make one of the best practical science exhibitions on earth. Their equipment would support a score of articles and even a comprehensive coverage can hardly do more than outline either activities or equipment.

For our purposes, Langley's activities may be broken down into these categories :

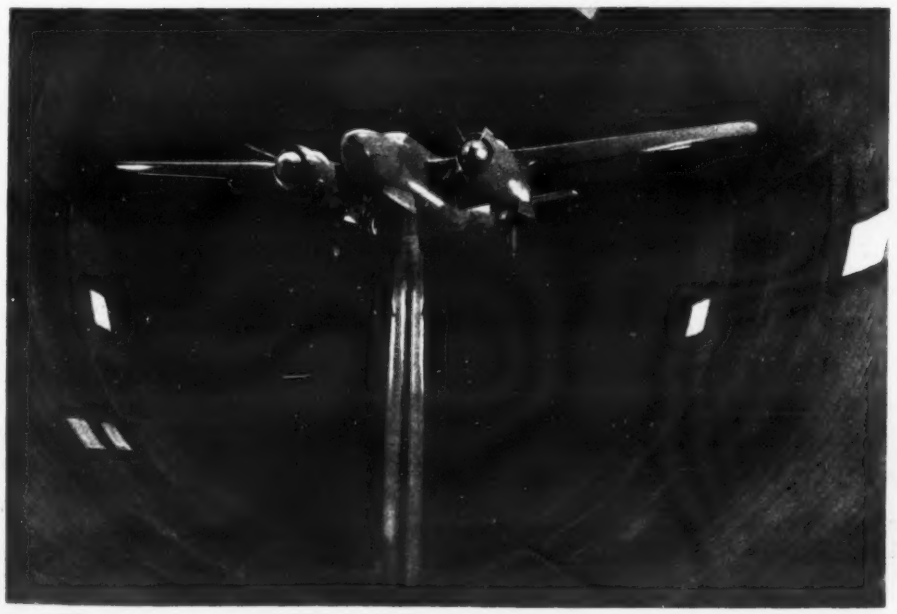
1. general aerodynamic research, both transonic and supersonic ;
2. airplane performance improvement ;
3. airplane stability and control ;
4. aerodynamics of aircraft engine installations ;
5. airplane propeller research ;
6. aircraft loading research ;
7. aircraft structural research ;
8. hydrodynamic research ;
9. missiles research.

With these broad points to establish the outlines of endeavour, a brief listing of the divisions of staff may help the reader to visualize the organization that pursues research in the above categories. These divisions are eight :

1. Aircraft Loads Division ;
2. Compressibility Research Division ;
3. Flight Research Division ;
4. Full Scale Research Division ;
5. Hydrodynamics Division ;
6. Structures Research Division ;
7. Physical Research Division ;
8. Stability Research Division.

A 0.2375-SCALE MODEL of a Douglas XA-26 light bomber mounted on the yaw support in the 19-foot pressure tunnel.

FINAL POLISH being given to an airfoil model before being tested in the Langley two-dimensional low-turbulence pressure tunnel, which has a narrow working section of 3 × 7 ½ feet. This tunnel requires 2,000 horsepower for velocities between 290 m.p.h. at atmospheric pressure and 150 m.p.h. at ten atmospheres. Preliminary studies are generally conducted in an unpressurized 200-horsepower tunnel featuring the same dimensions.



LANGLEY'S BIGGEST WIND TUNNEL can cope with a full-size Curtiss "Helldiver" naval dive-bomber.

HYDRODYNAMIC RESEARCH

NUMBER 1 TOWING TANK IS OVER HALF A MILE LONG. This photo shows a model of a four-engined flying-boat suspended from the towing carriage. It will be tested for stability, controllability, resistance, and spray characteristics, and can be towed in any desired position or depth.

DITCHING TESTS WITH LANDPLANES in towing tank No. 2 of the Hydrodynamics Division. The model is run up to flying speed and then freed to glide into the water, thus simulating a full-size ditching.

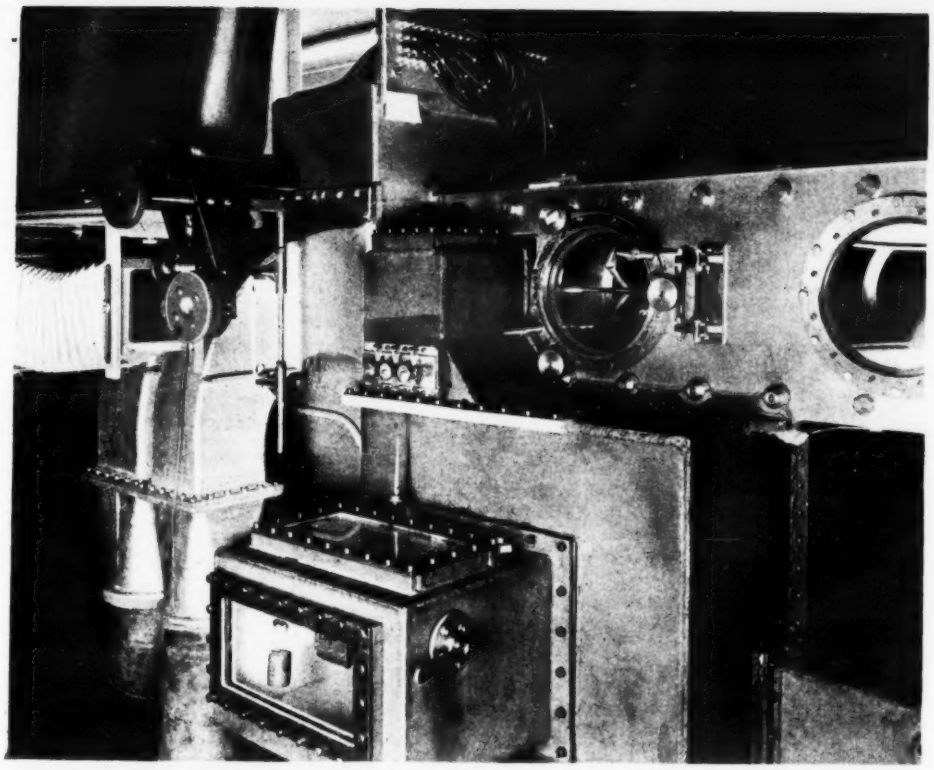
While the overwhelming complexity of this material compels a dependence on the old saying that "one picture is worth a thousand words," a brief review of some of the salient features in equipment will all the same help the reader to obtain a better understanding of the above outline and the accompanying photographs.

The *Aircraft Loads Division* relies mainly on the Gust Tunnel, in which the air forces under conditions of unsymmetrical flow can be determined with free-flight models. An Aircraft Loads Calibration Laboratory is used for observing the behaviour of airplane wings under loads exceeding those encountered in service, for calibrating flight load research instruments, and so forth. Further, the Division has at its disposal a 360 × 24 foot impact basin, for ascertaining the forces on floats and flying-boat hulls in simulated water landings; and a Special Projects Laboratory for problems of vibration, aging, etc., and the development of specialized equipment and measuring devices.

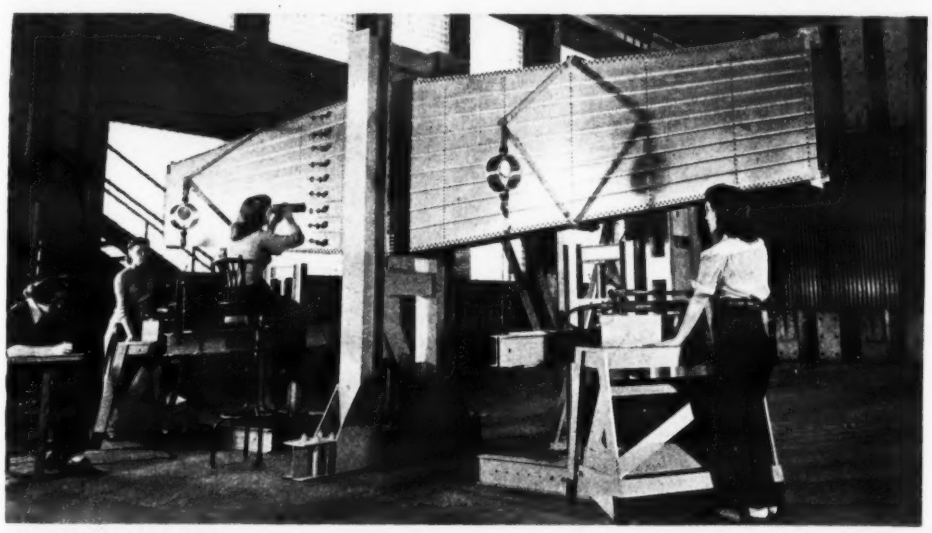
The *Compressibility Research Division,* where a wide range of problems occurring in the vicinity of sonic speed are dealt with, possesses a number of different wind tunnels : an eight-foot 760-m. p. h. tunnel ; a 16-foot tunnel with speeds up to 520 m. p. h. ; a 24-inch high-speed tunnel, and a 4 × 18 inch rectangular tunnel for approaching supersonic velocities ; and finally a supersonic tunnel capable of speeds up to Mach 2.5, with an interchangeable test section of 8 3/4 × 9 inches, or 4 × 20 inches.

The *Flight Research Division* conducts large operations with twenty-four airplanes for fundamental research, with an ever-changing assortment of military types flown in for corrective research.

The *Full Scale Research Division* can also carry out its tests in the wind tunnel, or substitute them with model tests in compressed air, thus eliminating the conversion calculations occurring in ordinary model tests. For these purposes the Division possesses an elaborate array of wind tunnels. One of these features a 19-foot diameter, in which the air can be put under a pressure 2 1/3 times normal atmosphere ; at the test section the air can be driven at speeds above 200 m. p. h. Two other tunnels, both for tests under two-dimensional flow conditions in a rectangular test section of 3 × 7 1/2 feet, are designed for specially low turbulence research ; the one working at normal atmospheric pressure, the other at pressures up to ten atmospheres and velocities up to 150 m. p. h. The Division's largest wind tunnel is big enough for testing 50-foot-span airplanes at airspeeds up to 120 m. p. h. There is furthermore an Induction Aerodynamics



AIRSPEEDS OF NEARLY 2,000 M. P. H. are attained in this supersonic wind tunnel, for supplementing research in the subsonic compressibility range.

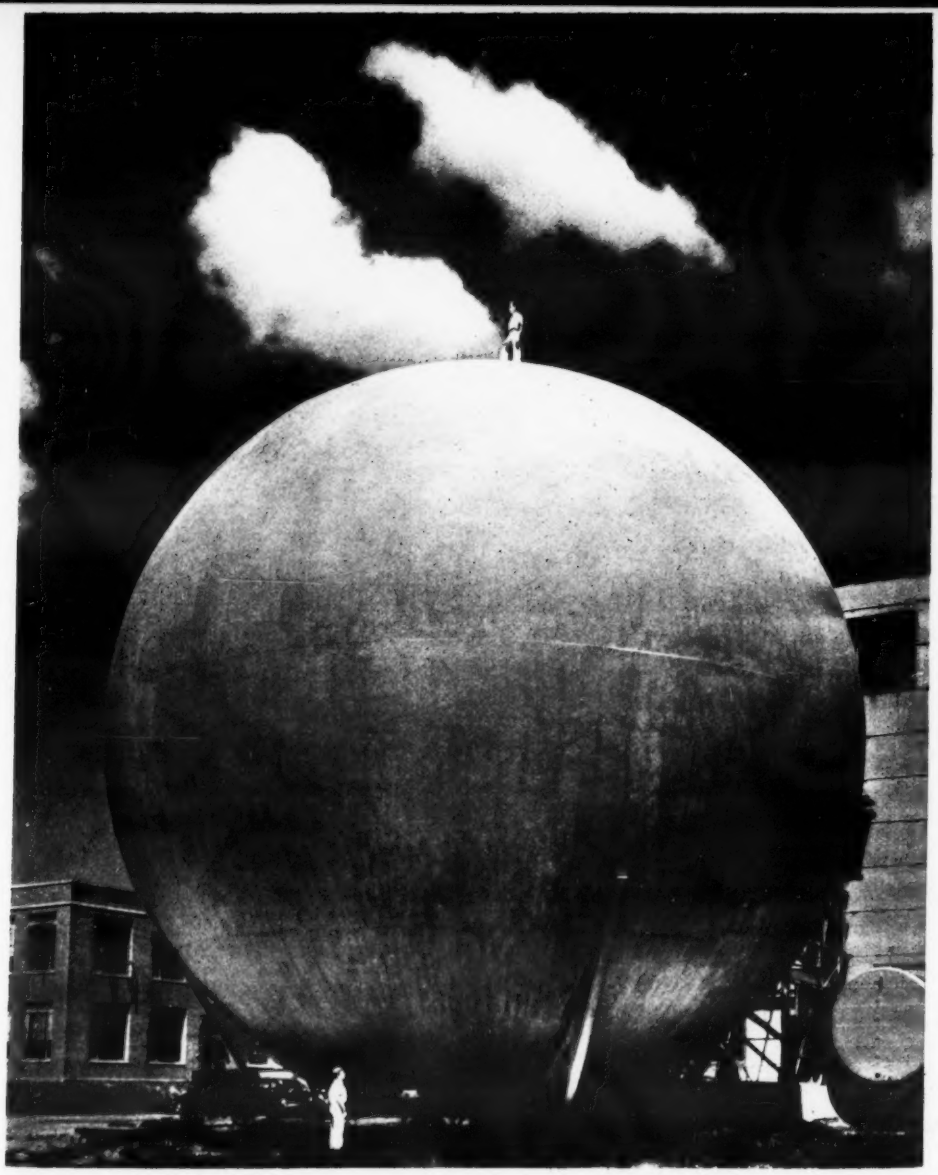


STRUCTURES RESEARCH

FOUR "NACA GIRLS" put a tapered box beam—simplified example of a stressed-skin wing—through a torsion test to observe the strain on the separate panels. Torsion forces are created by hydraulic presses.

PHYSICAL RESEARCH

SPINNING AIRPLANE MODELS, supported by vertically-rising air currents, are filmed. The Free Spinning Tunnel has a diameter of twenty feet and airspeeds up to 65 m.p.h. can be created.



STABILITY RESEARCH

THIS STEEL SPHERE, 60 feet in diameter, contains an entire wind tunnel 30 feet long with a 12-foot working section, in which free-flight models can be tested. The drive consists of a 600-horsepower electric motor, and the whole apparatus is mounted on bearings so that the tunnel can be tilted through a wide range of angles to correspond to the angle of glide of the model airplane. The sphere can be compressed up to two or more atmospheres ; a decompression chamber is provided so that the operators can return gradually to normal atmospheric pressure.

STABILITY AND CONTROL TESTS conducted with a model of the Bell X8-1 experimental supersonic airplane in the 7 × 10 foot rectangular tunnel at speeds up to 300 m.p.h. A second tunnel of this size enables measurements to be carried out at 500 m.p.h.

Laboratory, for research on flow at the intakes and inside of turbo power units.

The *Hydrodynamics Division* is equipped with two towing basins with towing carriages, for investigations on airplane floats and model flying-boats. The larger of the two basins is no less than 2,900 feet long, 24 feet wide and 12 feet deep, with carriage speeds up to 80 m. p. h. The smaller tank, which all the same has a length of 1,800 feet and is 18 feet wide by six feet deep, is equipped for carriage speeds up to 60 m. p. h.

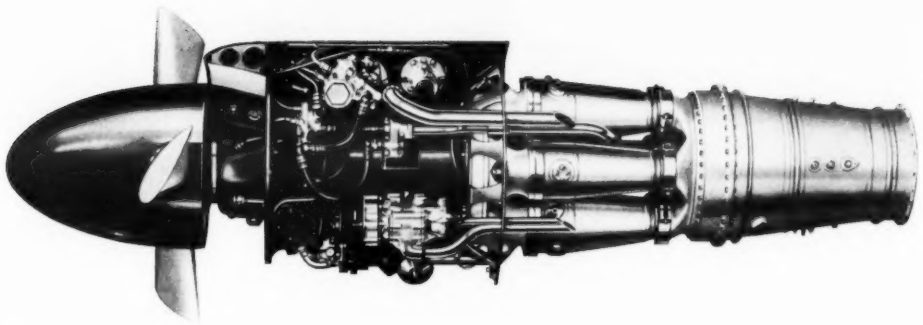
The *Structures Research Division* is equipped with the usual machines for applying compression or tension loads up to 600 tons, and jigs and fixtures for converting tension or compression into twisting forces.

The most unusual equipment from the spectator point of view probably belongs to the last two divisions of the Langley facilities. The *Physical Research Division,* for instance, includes a flutter tunnel in which Freon 12 gas is used instead of air. Since the speed of sound is reached at a much lower figure in Freon, the tunnel facilitates the investigation of certain phenomena occurring at very high speeds. This peculiar tunnel has a 4 ½-foot test section and is able to drive the air at up to sonic speed. There is furthermore a supersonic sphere, in which test objects are whirled at speeds exceeding that of sound, and which can be evacuated to 1/30 atmosphere so as to simulate air densities prevailing at altitudes of 75,000 feet. Another striking feature of this division is what is vaguely described as a "free flight apparatus," consisting of a 100-foot-long and 8-foot-wide gallery in which free-flight models can be propelled at speeds as high as 1,000 m. p. h. A helicopter tower and a potential-flow tank complete this division's chief equipment. This tank, incidentally, operates on the principle that the flow of electric current over an insulated model in liquid is analogous to the air flow over a body in the air stream.

Similarly unusual items equipping the *Stability Research Division* include a 12-foot free-flight tunnel inside a 60-foot pressure sphere, in which remote-controlled models fly under their own power. Widely publicized is the odd free-spinning tunnel, in which a 65 m. p. h. blast of air is directed vertically through a 20-foot test section, into which test models are launched. Remaining equipment includes normal types of wind tunnel : one for fundamental stability and control research ; another of 7 × 10 feet section, for airspeeds of 300 m. p. h. ; and a high-speed tunnel, likewise 7 × 10 feet, with variable maximum velocities (depending on interchangeable test section) of 500 m. p. h. and 700 m. p. h.

(To be continued.)

Armstrong Siddeley "Mamba"



On February 21st, 1948, a prototype of the Armstrong Siddeley " Mamba " airscrew gas-turbine engine satisfactorily completed the arduous Service Type Test as prescribed by the latest Air Ministry Civil and Military requirements : 150 hours' running, of which half at maximum take-off, maximum climb, and minimum idling speeds, as well as at various speeds within the cruising range, and the remaining hours at maximum cruising speed ; in addition, 100 starts, and 155 accelerations from slow running to full throttle within five seconds. Subsequently, when the engine was stripped and its internal parts minutely examined —some had run 320 hours— every item was found to be in satisfactory condition, thus perfectly conforming to the official requirements.

Since the 1946 S.B.A.C. Air Display, when the new engine was announced for the first time, one was rather inclined to award the " Mamba " its laurels in advance. Not only because Armstrong Siddeley Motors, Ltd., had already gained a reputation as manufacturers of reliable aero engines during World War I and had been working on the development of turbojets and turboprops since 1942, but above all because they had promised, in the " Mamba," a gas turbine of really low power output, though very high in proportion to its weight and dimensions : developing 1,010 shaft horsepower on the test bed, it is at last an aircraft gas turbine of " human size, " which will not have to await the advent of futuristic high-speed aircraft or expensive large types in order to prove its practical utility.

It will therefore be possible to install the first line-produced " Mambas " in aircraft having little revolutionary about them, which can temporarily be equipped with, or are already flying with, reciprocating engines : the Avro " Athena " and Boulton Paul " Balliol " three-seater trainers of the R.A.F., the Vickers Armstrong V.C.2. " Viscount " (development of the twin-engined "Viking") and Armstrong Whitworth A.W. 55 " Apollo " four-engined commercial transports, and the M.69 version of the Miles M.60 " Marathon," which is destined to have the M.60's four 325-H.P. piston engines replaced with two " Mambas."

Almost every time the Armstrong Siddeley company brings out a new engine, one has to delve into the Encyclopaedia Britannica to understand its name. The mamba happens to be a deadly type of snake (Dendraspis, if this is any help) found in Africa. It is six to seven feet long, thus only half as long as the python snake, after which the firm's first aircraft gas turbine [1] was named. Similar to the coiled form in which the python usually wraps itself around its prey, the air and gas channels of the big 2,700-H.P. turbine also run spirally. The " Mamba," on the contrary, is of pure axial-flow layout, accordingly being extremely simple in structure, and very slender. Maximum diameter over the cowling is 29 11/16 inches, and the overall length, from the rear face of the airscrew cone to the rear face of the turbine housing, 57 inches.

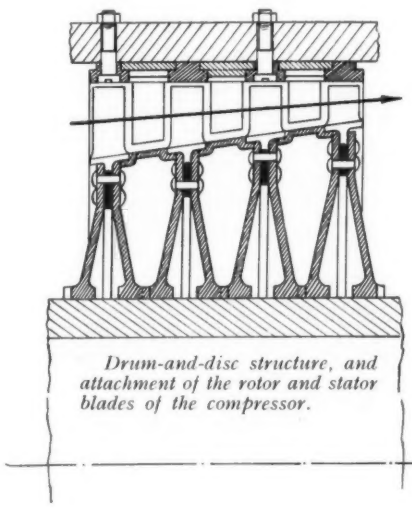
The annular air intake of the " Mamba " is built up from a magnesium housing, enclosing in its centre the airscrew reduction gears and carrying part of the accessories and their drives on its outer casing. The front end of the engine cowling is flanged to this outer casing, and can either be made to form a streamlined annulus directly aft of the airscrew, or alternatively to join with a ducted airscrew spinner so as to inhale and channel the engine air from a point already fore of the airscrew. The intake housing, tapering rearwards and leading the air directly to the compressor, actually contains the first row of inlet guide vanes, and also takes up two large angular-contact ball bearings, located one directly behind the other, supporting the front end of the compressor rotor.

[1] Cf. " INTERAVIA, Review of World Aviation," No. 3, Vol. I, P. 50-52.

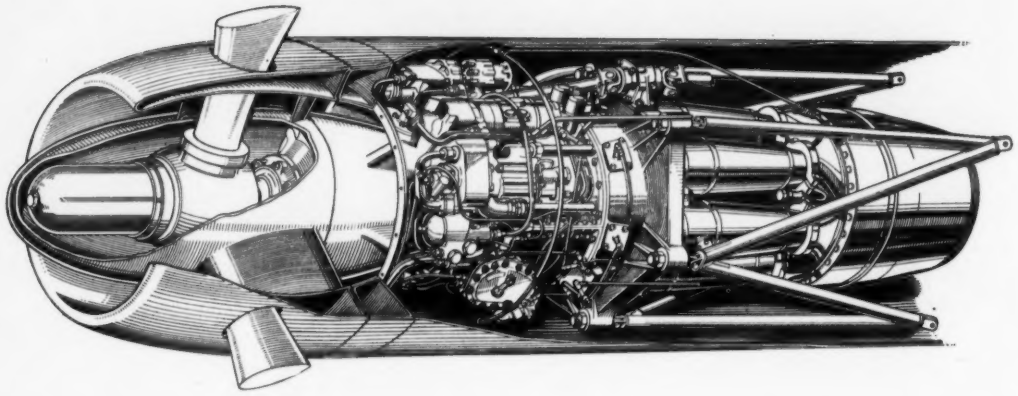
At starting speed of 15,000 r.p.m. the ten-stage axial-flow compressor uses 13.5 lbs. of air per second at sea-level, compressing it in a ratio of 5 : 1. Its cylindrical casing, formed by an upper and a lower casing-half of forged aluminium alloy, carries nine rows of aluminium stator blades which come to lie between the rows of rotor blades, and a double row of outlet straightener blades which impart an axial direction to the air stream aft of the last compressor stage. The roots of the stator blades dovetail axially into half-rings of T-section ; between them are located appropriately counter-profiled spacer half-rings, which hold them in position and are bolted to the casing. There are no bearings in the compressor casing.

The compressor rotor represents a rather unique combination of drum and disc-type construction : [2] the backbone of the rotor is constituted by a drum of stainless steel —experiments are being made with a drum of dural—on to which are shrunk ten pairs

[2] Cf. equally original construction of compressor rotor and other details for the Fedden " Cotswold " axial-flow turbine of 1,305 S.H.P., in " INTERAVIA, Review of World Aviation," No. 10, Vol. II, P. 31-35.



Drum-and-disc structure, and attachment of the rotor and stator blades of the compressor.



Showing the "Mamba" with a mounting structure picking up at six points of the centre casing, and designed to attach at four points of the aircraft. The intake casing extends to joint with a ducted spinner fore of the airscrew.

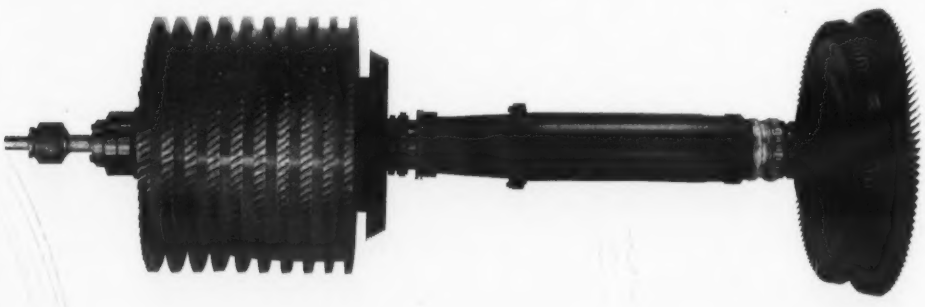
of steel discs. The T-shaped roots of the light-alloy rotor blades are slid between each pair of discs, and riveted to them. In addition, machined rings are located between the pairs of discs and, lodging beneath the blade roots, separate them from the next row of blades and come to lie opposite the tips of the stator blades. The discs of each pair are set at an acute angle opening towards the drum, and the outer faces of their flanges hooked to the outer faces of the next pair's flanges.

The rotor drum is supported by two flanged-on extension shafts. The upstream one is mounted on the afore-mentioned angular-contact ball bearings, which serve to centre it in the inlet housing; and it carries the small sun gear wheel of the airscrew reduction gear. The downstream extension shaft of the compressor rotor is mounted on a roller race, contained in a short centre casing joining on aft of the compressor, and is continued by a large-diameter hollow shaft through which the turbine drives the compressor. This centre casing fulfils a dual purpose. On the one hand, it forms the principal supporting element of the entire engine, and is consequently integral with the engine mounting, which can either be of three- or six-point design, and is provided with a metal structure for supporting the cowling. On the other hand, it supports the front ends of the six combustion chambers and ducts the compressor air to them. Between this centre casing and the rear end of the compressor drum are a cone, rotating with the drum, and a stationary ring, which together form a step-type labyrinth gas seal; the air pressure in the annular chambers exercises a forward thrust on the compressor rotor, thus helping to equalise the thrust.

Each of the six combustion chambers has a stainless steel outer casing, which is bolted upstream to the centre casing and, downstream, via a sliding joint to allow for expansion, enters the turbine feed manifold. Inside the casing is a flame tube of "Nimonic 75" steel. Although the manufacturers are still experimenting with various designs of combustion chamber, and do not disclose any details, it can be noted that each flame tube has only a small frontal opening and that the greater part of the air does not reach the combustion chamber proper until rather far downstream, after passing through staggered annular slits out of the air jacket between the outer casing and the flame tube. The fuel is not injected directly into the combustion zone, but first broken up under low pressure in the front part of the flame tube, then reversed to flow upstream so as to mix with the primary air coming from the frontal opening, and simultaneously vaporised. In this way it is only ignited in the rear half of the chamber. This principle has the advantage that the vaporisation, and thus the efficacy of the combustion, are much less dependent on the pressure and quantity of fuel delivered than in the case of direct injection. The six combustion chambers are connected by balance pipes. This equalises the pressure and enables starting to be carried out by igniter plugs in any two combustion chambers; and the "Mamba" effectively has only two igniter plugs.

A cylindrical casing extends between the combustion chambers, and flanged on to it is the turbine bearing, again a roller race.

Compressor and turbine rotating assembly. Left to right: helical sun gear of the airscrew reduction gear, two ball bearings, ten-stage compressor rotor, thrust-equalising rotor with step-type labyrinth seal, centre roller bearing, rear main shaft, turbine rear roller bearing, first and second turbine rotors.



The turbine feed manifold, into which flows the hot gas stream from the combustion chambers, and into which is built the first row of stator blades, has three pick-up points distributed over the periphery, from which tangential rods run to three points on the bearing casing. In this way the two parts are strongly joined, but in a manner allowing for radial expansion of the turbine feed manifold.

The two-stage turbine comprises two separate discs inter-connected by two rings with teeth engaging axially, the rings having about two-thirds the diameter of the discs. A hollow stub shaft, joining with a large flange to the first-stage disc, extends into the rear hollow shaft of the compressor, and the whole assembly is held together by a likewise hollow clamping bolt, which has its head in the rear main shaft of the compressor and a lockwasher behind the second-stage disc. Each disc carries 115 blades of "Nimonic 80," which, in accordance with the decrease in speed of flow, are longer on the second-stage disc. The blades are secured by fir-tree serrations in the disc rims. The second-stage turbine stator blades, lying between the two rows of rotor blades, are retained by a relatively high ring which, together with the toothed coupling of the two discs, forms a labyrinth seal. The second-stage stator ring is supported by the stator casing, on to which joins the outer exhaust cone. This tapers slightly towards the rear, and can be extended by the addition of cylindrical sections. The rear face of the turbine comes up against an inner exhaust cone, or bullet, supported inside the outer exhaust cover. There is no provision for regulating the diameter of the exhaust passage.

Understandably, the high temperatures occurring at the turbine call for adequate cooling by means of suitably-supplied cold air. Cooling air for the turbine bearing is piped externally from the fifth stage of compression, led to every part of the bearing housing, and ejected via the exhaust pipe. A second stream of cold air passes from the labyrinth seal on the rear face of the compressor through the casing surrounding the hollow main shaft, then through the hollow clamping bolt holding the turbine discs, and finally in radial direction along the second-stage turbine disc to be exhausted through the tail cone. In addition, air tapped through openings in the compressor drum is sent inside the rear main shaft towards the turbine, passing through the space between the clamping bolt and the

turbine stub shaft to cool the zone between the two turbine discs. Finally, there is an externally-piped stream of air from the centre casing to the front face of the first turbine disc. The rear bearing is also lubricated by about half a pint of metered oil per hour, so that its temperature does not greatly exceed 120 deg. C.

Now that the turbine engine proper has been described, the next lines will be devoted to the drive of the three-blade variable-pitch airscrew and the accessories. Since the turbine and compressor rotate at speeds up to 15,000 r.p.m., the airscrew gear, located in the housing fore of the compressor, reduces in the high ratio of 10.31 : 1 in order to keep the airscrew speed below 1,455 r.p.m. As stated earlier, the forward extension shaft of the compressor carries the helical sun gear wheel of the planet gearing. It engages three helical satellites,

Centre casing with three-point mounting. The annular combustion chamber inlet manifold, seen here from the front, takes air from the compressor through its six segments and leads it to the combustion chamber lying on the rear face.

to which are attached three smaller spur planet gears, turning inside a fixed internal gear. The extremities of the three pinions carrying the planet compounds—mounted on a roller bearing at the front and on a ball-and-roller bearing at the back—mesh with a carrier which is fixed to the airscrew shaft. Thus the latter turns with the satellites about the reduction gear shaft, and rotates in the same direction as the compressor and turbine rotors.

If we compare this gear arrangement with that of other airscrew-turbines described in " Interavia Review," we see that the " Mamba " reduction gear, with its eight gear wheels, is less complicated than that

Turbine feed manifold, showing the first stator blades and the six supports which join to the combustion chambers. The casing of the turbine bearing is suspended by three rods from the inner flange of the feed manifold.

Second row of turbine stator blades, with labyrinth seal at inner ring, which is located between the turbine discs.

of the fast-rotating Fedden " Cotswold "[3] (five double and seven single gear wheels), but requires one set of planets more than the reduction gear of the Bristol " Theseus,"[4] in which the same planet wheels mesh with the sun wheel and the fixed internal gear.

As in the case of these two other airscrew-turbines, the fixed internal gear of the " Mamba " is mounted so as to enable the torque moment to be measured at it —thus the power transmitted to the airscrew. Eight bell cranks couple with their shorter arm to the fixed internal gear, each longer arm being supported by the piston of a radially-disposed pressure-oil cylinder, representing a torquemeter. Increased oil pressure is recorded by a torquemeter pressure gauge. If the torque drops to zero, or to a negative value, a switch operated by one of the cranks is tripped and the airscrew blades are automatically feathered.

The short airscrew shaft is carried in a large ball bearing, which simultaneously takes the entire airscrew thrust. Within a bore at the rear end of the airscrew shaft is carried a bronze bush, into which the forward end of the torsion shaft runs.

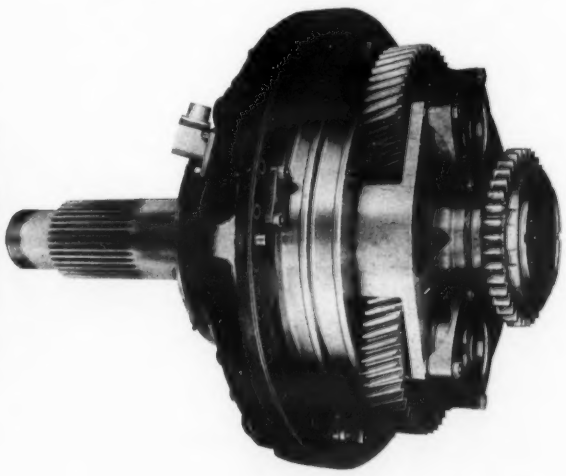
A spur gear bolted to the back of the satellite carrier drives—through a train of spur and bevel idlers, and a single inclined bevel shaft passing through one of the aerofoils in the annular intake—the following accessories, of which the first three are mounted on the intake casing and the others above the compressor, all parallel to the engine axis : —

1. High-pressure oil pump
2. Governor-operated ignition switch
3. Electric tachometer
4. Main oil pump unit (pressure, scavenge, and micro-metering pumps)
5. Airscrew constant-speed unit
6. Drive for remote aircraft accessories gearbox (on the wing spar or on the member supporting the tail pipe) with a capacity of 50 H.P.
7. Electric starter (8 H.P.)
8. Fuel pump with engine over-speed governor.

[3] Cf. Footnote No. 2.

[4] Cf. " INTERAVIA, Review of World Aviation," No. 3, Vol. I, P. 52-54.

Casing to the airscrew reduction gear. The internal gear is supported by the bell cranks on the eight pressure-oil cylinders of the torquemeter.



Airscrew reduction gear. The large helical planets mesh with the small sun wheel located on the torsion shaft. Visible to the far right of the planet carrier, which is located on the airscrew shaft, is the gear providing the drive for the engine auxiliaries.

" Mambalanc," the " Lancaster " bomber converted into a flying test bed for the " Mamba."

The purpose and functioning of these accessories are largely self-explanatory. For supplying and metering the fuel, the " Mamba " has a Lucas system, which has much in common with the systems adopted for the Rolls-Royce " Nene " [5] and other British turbines.

The blade pitch control, or constant-speed unit, and the manual control for fuel, are coupled together in an automatic control device, so that the pilot only has to operate a single lever for both purposes. This device takes care that the blades are feathered when the engine is being started or idling, and that the engine speed is matched to the fuel flow at any instant, to prevent surging or overshooting of the engine during acceleration periods. Thus the speed governor, which would incur a drop in output, is not used. As a matter of fact, the " Mamba " can be accelerated from idling to full thrust in two seconds, which is a particularly valuable asset in the case of a zoom after a misjudged landing attempt.

Now that the bench trials with the new engine have been completed, it is being flight-tested. A " Mamba " has already been installed as a fifth engine in the nose of a " Lancaster," and left the ground in this manner on October 14th, 1947. The flight tests are to be very thorough and may possibly last a year. And by the time these lines are in print, it may be that the "Mamba" will already have accomplished its first " solo " in one of the afore-mentioned " Athena " or " Balliol " trainers. *T.*

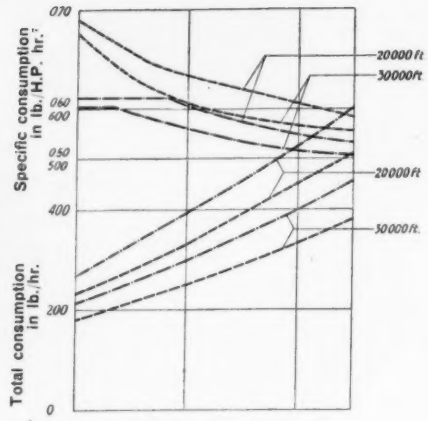
MAIN DIMENSIONS

Maximum diameter of stripped engine	27½ ins.
with cowling	29 11/16 ins.
Frontal area with cowling	4.81 sq. ft.
Length from rear face of airscrew fitting cone to rear face of turbine housing	57 ins.
Min. length of exhaust cone	12 ins.
Airscrew reduction	10.3 : 1
Power per unit frontal area (take-off equivalent power)	235 H.P./sq. ft.

WEIGHTS

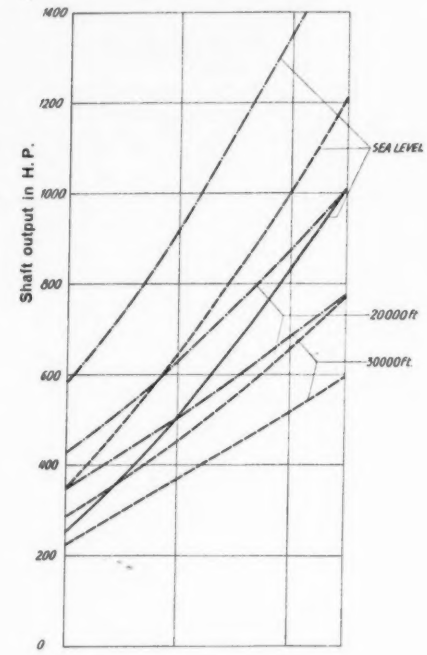
Dry weight without cowling	760 lbs.
Specific weight, in relation to max. equivalent shaft horsepower	0.675 lb./H.P.

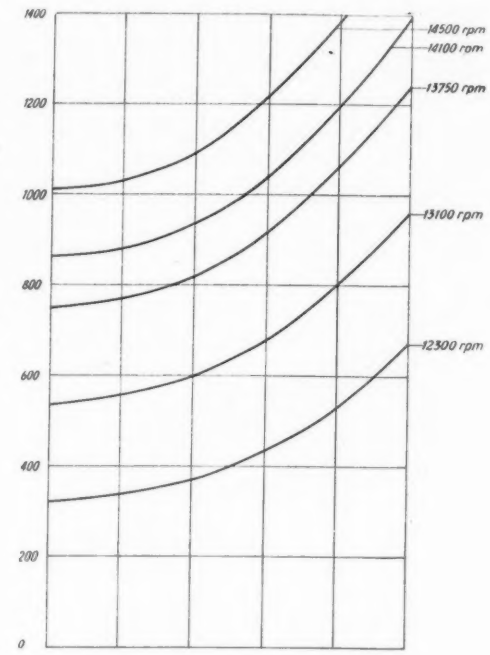
[5] Cf. " INTERAVIA, Review of World Aviation," No. 2, Vol I, P. 37-42.

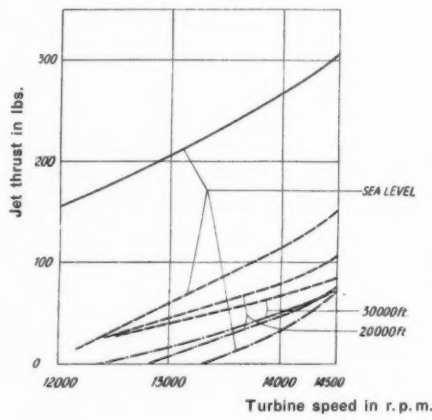


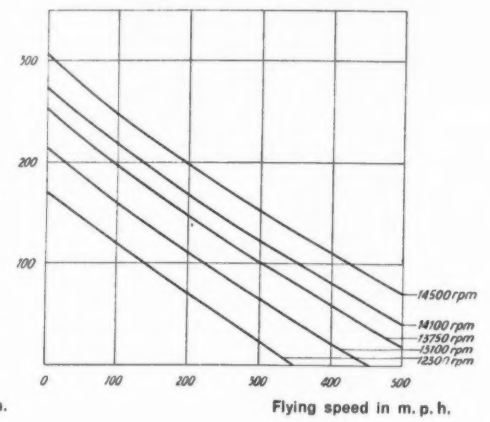
Shaft power and jet thrust of the Armstrong Siddeley " Mamba ": left, versus r.p.m. for varying altitude and speed ; right, versus speed for varying r.p.m. (at sea level). Top left are also total hourly fuel consumption, and specific consumption in relation to equivalent shaft horsepower (assuming 80 % airscrew efficiency). All curves valid for an experimental version, with max. speed of 14,500 r.p.m. being a little slower than the standard model, but delivering the same output.

——— static
– – – – – – flying speed 300 m.p.h.
—·—·—·— flying speed 500 m.p.h.









OUTPUT AND CONSUMPTION at sea-level

OPERATING VALUES

Maximum air flow		13.5 lb./sec.			
Compressor :	Compression ratio	1 : 5	*Turbine :*	Inlet pressure	57.5 lb./sq. in.
	Outlet pressure	60 lb./sq. in.		Outlet pressure	1.75 lb./sq. in.
	Outlet temperature	230 deg. C.		Absolute gas velocity in first stage	2,000 ft./sec.
Combustion chambers :	Weight ratio air : fuel	55 : 1		Axial velocity at outlet	855 ft./sec.
	Air surplus	15 : 1	*Oil consumption*		2 pints/hr.
				Combustion temperature	2,000 deg. C.

Operating condition	Engine speed r.p.m.	Flying speed m.p.h.	Shaft horsepower	Jet thrust lbs.	Equivalent shaft horsepower [6]	Fuel consumption Gall./hr.	Specific fuel consumption lb./H.P. hr. [7]
Take-off power	15,000	0	1,010	307	1,128	102	0.73
Emergency power	15,000	100	1,032	248	1,115	104.1	0.745
Climbing power	14,500	200	935	170	1,049	94.8	0.73
Cont. cruise power	14,000	300	918	102	1,029	89.5	0.71

[6] Airscrew efficiency assumed at 80% and equivalent shaft power, in static condition, at 1 H.P. per 2.6 lbs. thrust.

[7] In relation to equivalent shaft horsepower ; specific weight of fuel taken at 0.81.

Jet Engine Test Bed for High-Speed Conditions

By W. Spillman, D.Sc., Lucerne

It is a known fact that calculation and construction alone do not yet enable us to guarantee, always and with absolute sureness, that our machines will function perfectly. Even when we are acquainted with the different physical phenomena involved —it often occurs that we can only describe them in their simplest form—perhaps we still cannot fully comprehend their combined effect. Because such situations are very characteristic of aircraft design, in this domain we are compelled to carry out tests embracing the " elementary " phenomena in their entirety. This also applies to the testing of aircraft power plants, and we have always endeavoured to build test beds enabling actual operating conditions to be simulated as closely as possible.

For reciprocating engines this could be done by using altitude test beds and air-conditioned wind tunnels. Logically enough, analogous installations would also be very useful for testing turbojets and airscrew-turbines, and their regulating systems. Meanwhile, in view of the much greater air consumption of turbines, compared with piston engines, the cost and complication of such installations would be prohibitive. And as a matter of fact the present turbine engines have been developed without the necessity for such expensive set-ups. For testing turbines it has so far been possible to use simple installations and a limited number of all the same accurate measuring instruments, since here the primary task of the test bed is not so much the adjustment and regulation as the determination of the operating characteristics, whereby the interrelation of the forces, temperatures and pressures must be ascertained with especially great precision.

It is not absolutely necessary to test a jet engine on a complete altitude test bench. A general examination of its function without automatic speed governor successfully shows that, for operating conditions not influenced by critical limits (Mach number, pump-feed limit), the turbine's behaviour at altitude can be very accurately determined on the sea-level test bed. The aim of the present article is to deal with the relations existing between these two conditions.

By following the principle of similitude and comparing the dimensions, we can form, for jet engines, coefficients similar to those utilised in the study of the transmission of heat, and which bear the names of Reynolds, Nusselt, Prandtl, and so on.

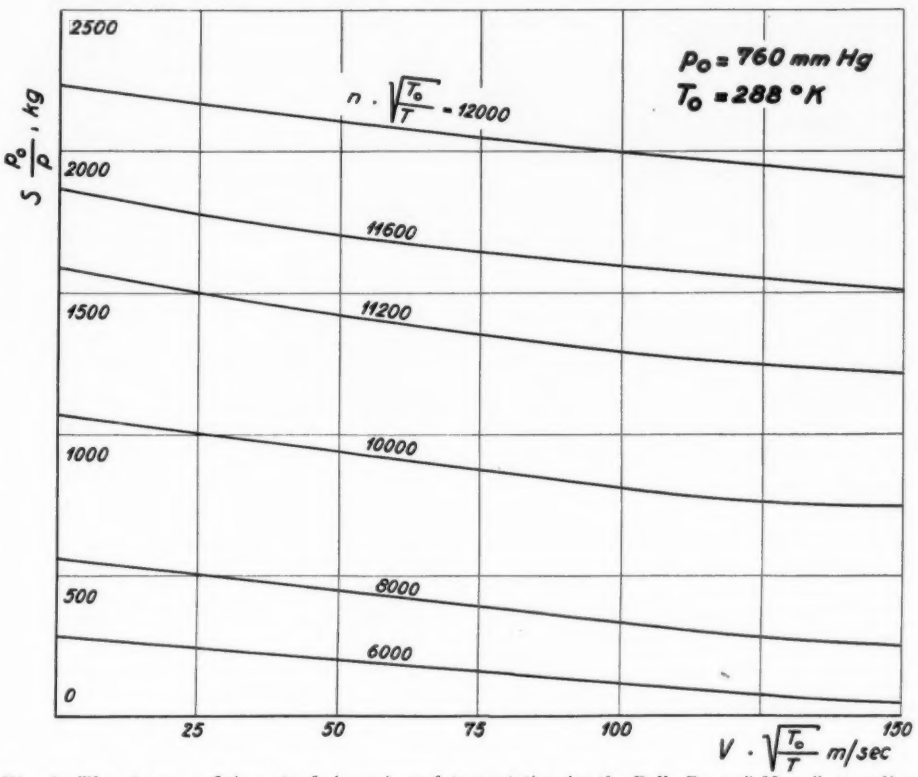


Fig. 1: Thrust versus flying speed, in universal presentation for the Rolls-Royce " Nene " according to measurements made on the test bed for high-speed conditions.

Coefficients

Air mass flow M (mass units/sec.)	$M' = \frac{M}{F}\,\frac{1}{\rho a}$
Impulse I (kg. sec.)	$I' = \frac{I}{F^{\frac{3}{2}}}\,\frac{1}{\rho a}$
Thrust S (kgs.)	$S' = \frac{S}{F}\,\frac{1}{\rho a^2}$
Work A (mkg)	$A' = \frac{A}{F^{\frac{3}{2}}}\,\frac{1}{\rho a^2}$
Output W (mkg/sec.) from fuel mass flow B (kg/sec.) times calorific value H (mkg/kg.)	$B' = \frac{B}{F}\,\frac{1}{\rho a^3}$
Number of revolutions n (sec^{-1})	$n' = \frac{n}{a}\sqrt{F}$
Flying speed v (m/sec.)	$v' = \frac{v}{a}$ (Mach number)

* Coefficient n' can be replaced with "Mach number of peripheral speed " M_u. Other dimensionless coefficients can be formed for pressure, temperature, volume, mass, kinematic viscosity, mass inertia moment, etc.

These relations are valid in a general manner, independently of the system of units or construction of the machine, and for as long as the determinant phenomena are reversible and principally dependent on the basic units selected. With the help of these coefficients the various operating conditions can be represented very simply: for example, the thrust and the flying speed for a given number of revolutions can be presented for all altitudes by one single curve (Fig. 1).

The general equations completing the bed tests have the particular form of the correctional formulae generally used for converting to normal conditions (sea level), and which have also been calculated by other methods.[1] Fig. 2 is a graphic presentation of the corrections, as prescribed by the conversion formulae, to be made to a number of measured values for the thrust and r.p.m. of a simple turbojet engine.

Control tests here show the general coefficients to be utilisable within very wide limits, and that they are also adequate for studying the behaviour at altitude. As

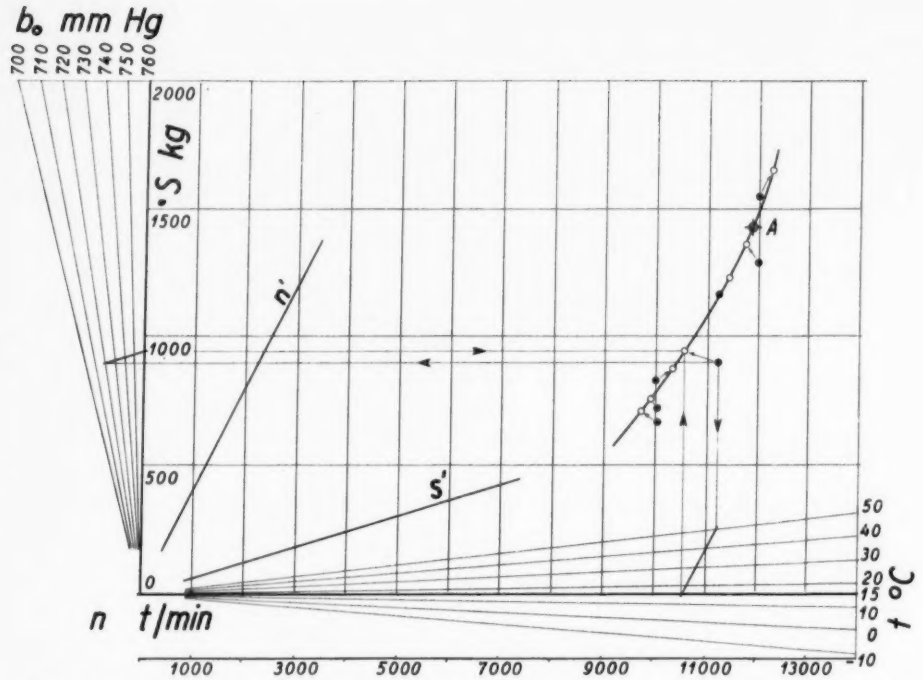


Fig. 2: Measured results converted graphically to normal conditions. Orthogonals must be drawn from the measurement points up to the barometric pressure b_0 and the ambient temperature t. The directions of the auxiliary lines enable the corrected thrust and r.p.m. to be read off the diagram axes, which determine the new point (located on the curve) for the normal conditions at sea-level.
n' = auxiliary line for n
S' = auxiliary line for S

" altitude formula " for the thrust,[2] use is frequently made of the relation

$$S \sim \rho a^2$$

The inter-dependence of the dimensionless coefficients, meanwhile, makes it necessary for us to take the other coefficients simultaneously into account, in this case of

$$n : \sqrt{T} = \text{constant}$$

(T = temperature before the engine). But because the " altitude curves " for the thrust are generally based on a constant number of revolutions n, the thrust must be converted, taking into account its relation with the r.p.m., for a constant value of the latter.

In the event where the thrust varies with the cube of the r.p.m., the dependence for constant r.p.m. is :—

$$S \sim \frac{\rho}{a}$$

Expressed with other units, this formula leads to one of the formulae recommended by the ICAO-AIR/OPS Committee on Temperature Accountability (meeting of September, 1947, in Paris) for the " lower limit " of the influence of altitude. As the " upper limit " this committee recommended :

$$S = \frac{\rho}{a^3}$$

which corresponds to an increase in thrust with the fifth power of the number of revolutions. Fig. 3 demonstrates that these altitude formulae coincide well with the measured values, if exception is made of turbojets with variable jet cross-section (Jumo) or with heat exchangers (Bristol " Theseus ").

Understandably, the static behaviour at altitude does not take into account the flight condition. It is still indispensable to know the *influence of the flying speed.* Here it is generally impossible to convert from simple static tests on the ground, as the suction conditions of the compressor, thus of the suction diffusors, play a decisive part in this instance. The utilisation of the dynamic pressure is dependent on the efficiency of the suction diffusor ; and it therefore concerns a question of configuration and installation, which must be clarified experimentally. If it is not desired to carry out such experiments independently of the engine, it is of course necessary to have at disposal a sufficient air mass flow, and pressure conditions corresponding to the dynamic pressure. Then the engine has to be fed at dynamic pressure or the inlet diffusor placed in an air stream fast enough to correspond to the flying speed.

Efforts aiming to satisfy this condition have led to the construction of a *test bed for ground testing under high-speed flight conditions,** which represents a complement to an existing installation for testing aircraft engines under altitude conditions.[3]

The compressors of the altitude test bed were initially installed for an air mass flow of 3 kgs. per second, for testing high-power aircraft engines at altitudes up to about 11,000 metres. For coping with the much greater air mass flows required by jet engines, the various compressors have been coupled together in such a way as to enable a large *jet blower* (Fig. 4) to be operated. The annular nozzle of this blower is fed by a low-pressure ventilator, inhaling about 35 cu. m. of air per second. Inside the annular nozzle is the central feed nozzle, obtaining its air from two parallel-coupled compres-

* This altitude test bed for aero engines was built by the Brown, Boveri Co., Baden, under contract to the Technical Service of the Swiss Federal Military Department. Its later development was carried out according to a project and plans of the Swiss Federal Aircraft Works at Emmen, and is now operated by this firm's research department.

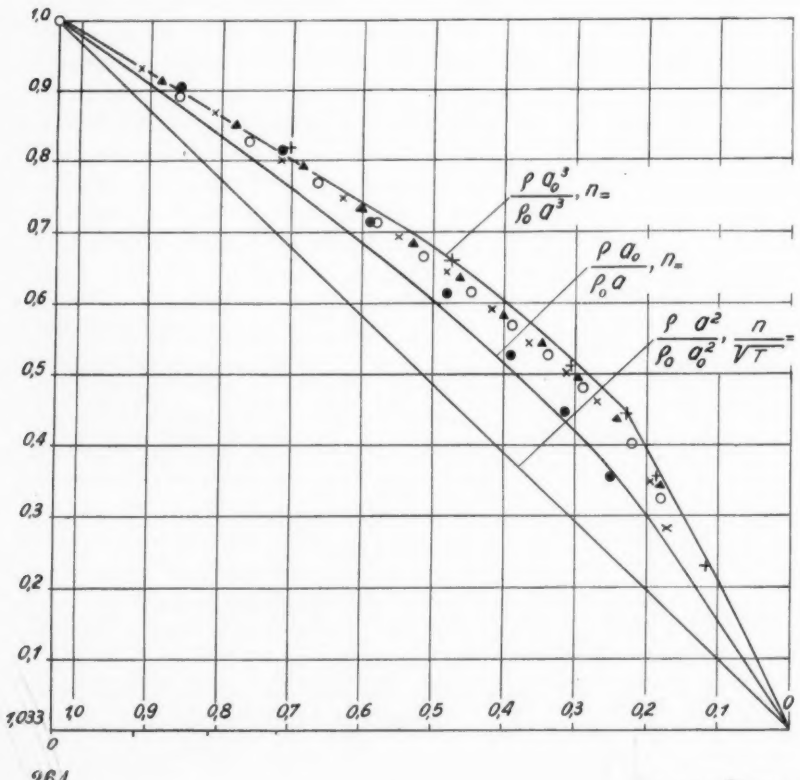


Fig. 3: Thrust variation of turbojets without jet pipe adjustment or heat exchanger, versus altitude.

- ○ Rolls-Royce " Nene 100 "
- ▲ Rolls-Royce " Derwent V "
- × de Havilland " Goblin II "
- \+ de Havilland " Ghost "

} Flying speed 800 km/h, Maximum r.p.m.

- ● Jumo 004 with variable jet pipe section

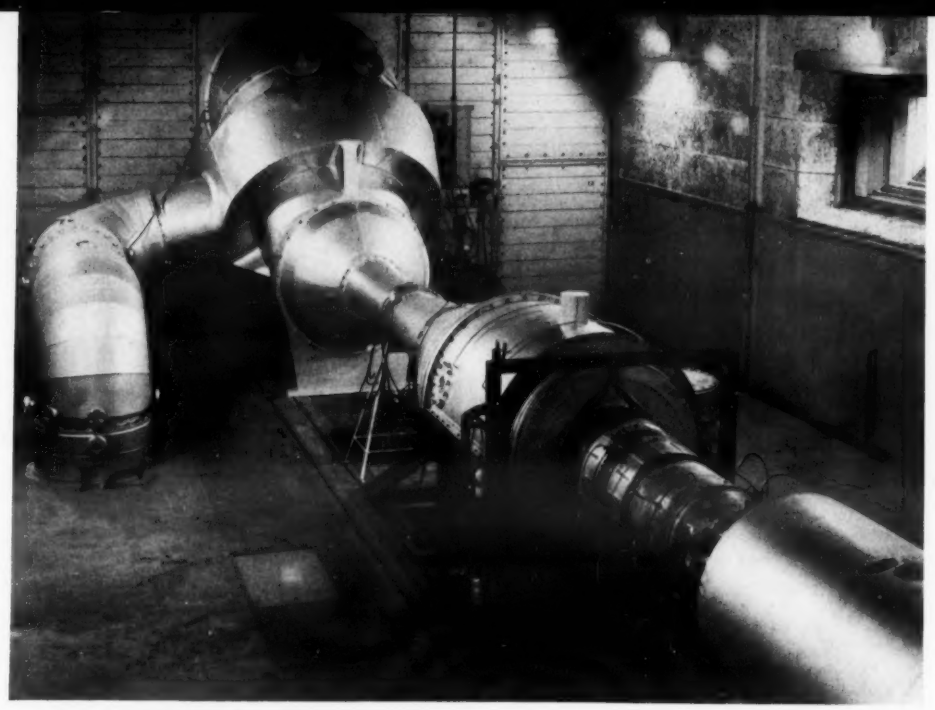


Fig. 4: Dynamic pressure tunnel

To the rear: left, high-pressure air entry; centre, ejector; right, anti-pumping regulators
In the centre: engine in pressure chamber and on the rolling platform
Front right: jet nozzle and exhaust silencer
Righthand wall: observation window

sors and developing supersonic velocities at its outlet. The low-pressure air of the axial ventilator is accelerated by the central jet. The two air streams are mixed together in the connecting pipe, with the result that a steady velocity is obtained at the outlet of the diffusor. In order that the mixing pipe should not be too long, it was necessary to conduct a careful study to find out the best form for it. The form of the diffusor joining on to this pipe has to be adapted to the jet engine being tested, whereby full account can be taken of the installation in the aircraft. Return-flow turbojets are installed in a pressure chamber, in which a certain part of the dynamic pressure is reached, depending on the inhaling speed of the compressor (Fig. 5).

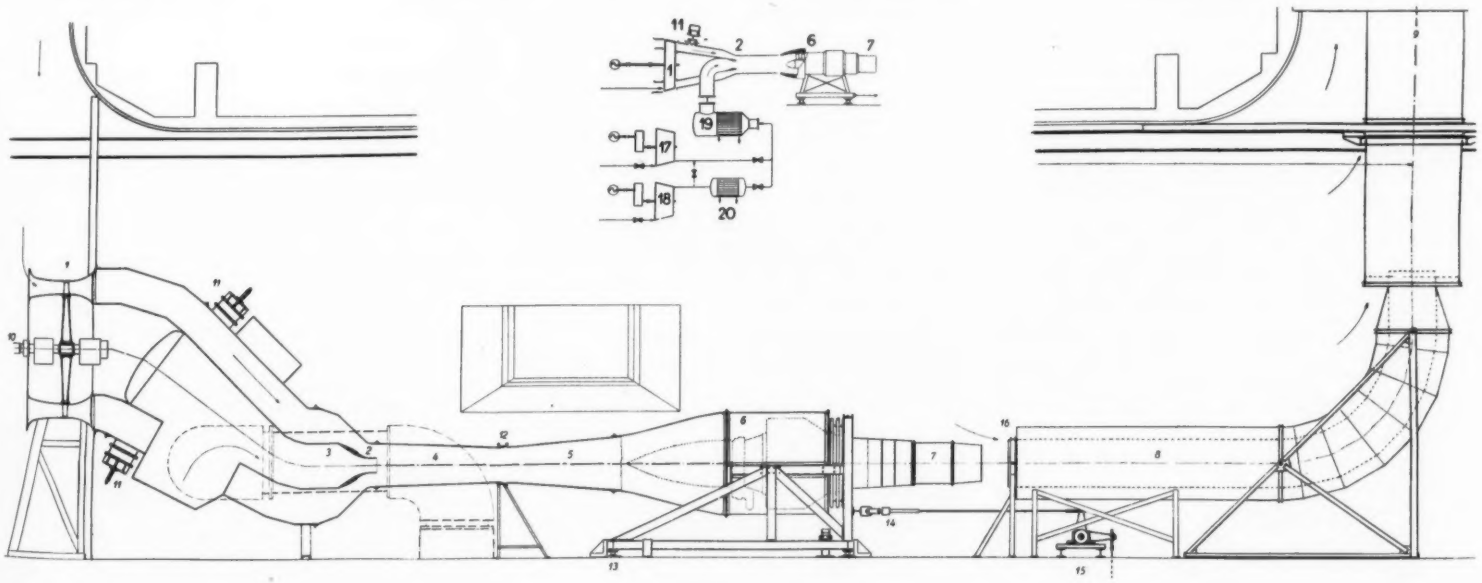
The exhaust gases leave by the free pipe located outside the pressure chamber, and cross through a silencer which leads them to a chimney. To cut down their temperature, air is mixed with the exhaust gases by using the ejector action between the pipe and the silencer, and further on, after the elbow. Despite this, the temperature curve can still feature high peaks, for which reason the chimney, which also acts as a silencer, is lined with fire-clay. The exhaust pipe assembly being fully enclosed in the laboratory gives a certain degree of sound-proofing, which obviates any outside disturbance caused by the noise, and which notably absorbs high frequencies altogether.

The necessary freedom of movement of the engine in axial direction, for measuring the thrust, has been achieved by cutting the entry channel at the point where the pressure in the mixing section approximately reaches atmospheric pressure. At this spot a number of measuring points have been installed for registering the speed and temperature distribution. Diffusor, pressure chamber and nozzle are rigidly coupled with the engine and jointly mounted on a platform which rolls on steel spheres carefully located between glass-hard surfaces. The entire mobile and almost frictionless system is connected by a rod, carrying a hydraulic strain gauge, to a balance which can weigh between 0 and 3,500 kilograms. By applying weights direct to the rolling platform, the balance can be calibrated with the entire transmission system. The maximum recording error is 0.2 per cent., which value has not varied in one year of operation.

Regulation of the dynamic pressure wind tunnel can be accomplished in a very simple manner by a remote control, since the low-pressure ventilator and one of high-pressure compressors have variable numbers of r.p.m. For the axial ventilator an electric "anti-pumping" regulator had to be built, which acts on the discharge valves and works chiefly during the starting process. For special purposes, the temperature in the tunnel can be varied within certain limits by inserting coolers and, for small air mass flows, two refrigerating machines. The instrumentisation comprises the usual equipment, supplemented by an accurate revolution-counter (impulse-counter), by which

Fig. 5: Schematic presentation and section view of the test bed, showing jet blower and engine in air tunnel.

1. Axial ventilator
2. Annular nozzle
3. High-pressure ejector
4. Mixing section
5. Diffusor
6. Pressure chamber containing "Nene"
7. Exhaust with jet cone
8. Silencer
9. Chimney
10. Shaft to l.p. ventilator
11. Anti-pumping valves
12. Cut and measuring section
13. Rolling platform
14. Hydraulic strain gauge
15. Rods to balance
16. Mixture of air
17. Variable-speed h.p. ventilator
18. Non-variable h.p. ventilator
19. Air cooler
20. Cooler fed by refrigerator



the interruptions of an electric contact mounted on the engine are counted with absolute accuracy.

This test installation has the advantage that, with a relatively small number of machinery units, following ı few simple transformations, it can, as an altitude test bed, drive a decompression chamber and a small low-temperature wind tunnel, and thus has a very wide field of application. The compressors can be coupled in series for supplying high pressures (altitude tests, evacuation of the decompression chamber and the supersonic tunnel), parallel for large air mass flows (testing combustion chambers) and coupled in accordance with the ejector system described earlier on, for testing jet engines. In the last case, for example, a temperature of 0 deg. C. is obtained in front of the engine, this for an inlet temperature of 20 deg. C. at the low-pressure ventilator, with the latter inhaling 40 kgs. of air per second ; indeed, owing to expansion, the air coming from the high-pressure nozzle features a temperature of —45 deg. C. Depending on the form of the diffusor, and for the air mass flow indicated, flying speeds up to about 700 km/h can be simulated, whereby the entire system consumes up to 2,800 kw. For smaller turbojets the measuring range is extended in many respects.

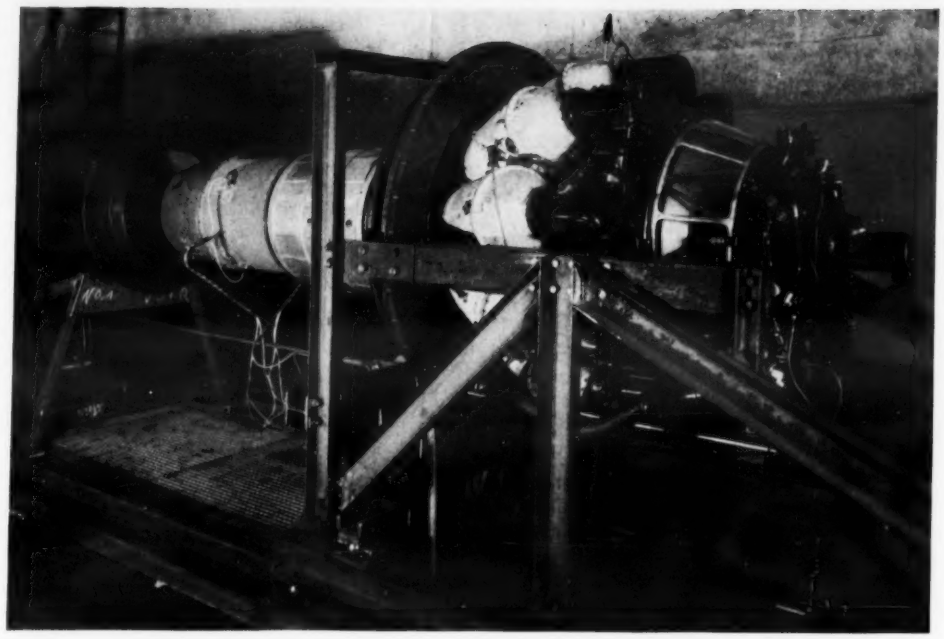


Fig. 6 : Rolls-Royce " Nene " on rolling platform, without air tunnel and pressure chamber.

By utilising the available refrigerating equipment, temperatures as low as 0 deg. C. can be reached in front of the engine, so that climatic variations and also icing conditions can be simulated. This opens a new domain to research workers, and one in which many problems remain to be solved.

1. British Airworthiness Requirements
2. K. R. Scheuter : Theoretische Betrachtungen über einige Strahltriebwerke, " Flugwehr- und Technik, " 1946, P. 290.
3. Brown, Boveri Mitteilungen, Jan./Feb., 1946, P. 37 and W. Spillmann : Flugmotoren-Höhenprüfanlage der Kriegstechnischen Abteilung, " Flugwehr- und Technik " 1946, No. 4/5.

Jet-Propelled Personal Aircraft ?

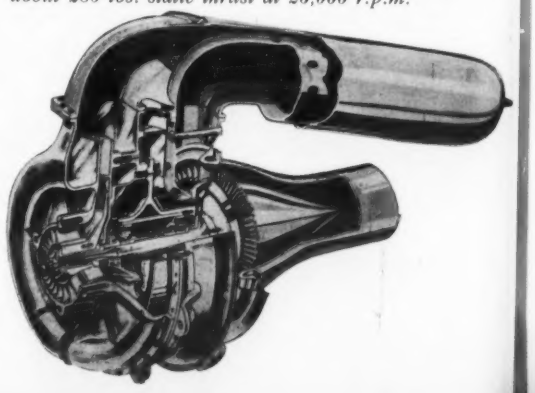
Luxury-type four-seater touring aircraft such as the " Bonanza, " " Navion, " " Noralpha " and so on, today attain speeds of 150 to 200 m.p.h. with reciprocating engines of 165 to 240 H.P. rated power. Thus they can fly in about three hours from Paris to Bilbao, Dublin or Hamburg, or from New York to Quebec. One might be tempted to think that such performance would satisfy even the most speed-crazy travellers. Aircraft designers, however, are not so satisfied, and are intent on working out new, faster projects. Now that the jet- propulsion engine has brought about revolutionary changes in fighter aircraft design, and bombers, too, are adopting this latest form of prime mover, an attempt is also being made to have the " new look " in aircraft manufacture, and the greater speeds accompanying it, invade the domain of personal aircraft.

It is obvious that such plans and projects cannot materialise until suitable small engines are available. For the time being only one airscrew-turbine has been developed which would be suitable for light touring aircraft : the frequently-mentioned Boeing Model 502 pusher type delivering 200 shaft horsepower. True, there are also a few pure jet engines of low output—for example the Westinghouse X9.5A and X9.5B axial-flow turbines and the Boeing Model 500 with radial compressor—but their thrust output (150-270 lbs. at approximately 35,000 r.p.m.) is not sufficient for powering long-range light aircraft ; and the next largest aircraft turbine engines already overstep the power limits for this particular field of application.

Meanwhile, the news now comes that a young U.S. West Coast engineer, Edward West, Jr., has not only designed a four-seater tourer for jet propulsion, but—what is still more important—has done some very promising preliminary work which may lead up to the line-production of the necessary power plant. Like most Americans, Mr. West is a practical man. He tackled the problem from the acquisition angle, and started his project by buying 6,000 new superchargers for piston engines from war surplus stock, with the idea of converting them into small turbines. Converting the supercharger into a turbo-jet engine has been largely successful. Although the present engine only develops about 280 lbs. static thrust (at 26,000 r.p.m.), whereas Mr. West needs at least 400 lbs. for his aircraft project, this enterprising designer is convinced that further modifications to the compressor will enable the target output to be reached.

The new jet engine under development by West Engineering Co., Los Angeles, is illustrated here diagrammatically. It is a single-stage radial compressor type, of which the root element—the conventional super-

West Engineering Co. built this jet engine around an ordinary supercharger. At present it develops about 280 lbs. static thrust at 26,000 r.p.m.



charger—is still plainly discernible. The added parts comprise a combustion chamber, in which a reversal of flow occurs, a special injector nozzle and an exhaust duct, both the latter having fixed efflux cross-sections. To improve the output, meanwhile, the 144 turbine blades of the supercharger had to be replaced with new ones. It is also stated that the compressor blades will likewise have to be changed against new ones of greater depth and superior aerodynamic form. Nothing is said about provisions for regulation and control.

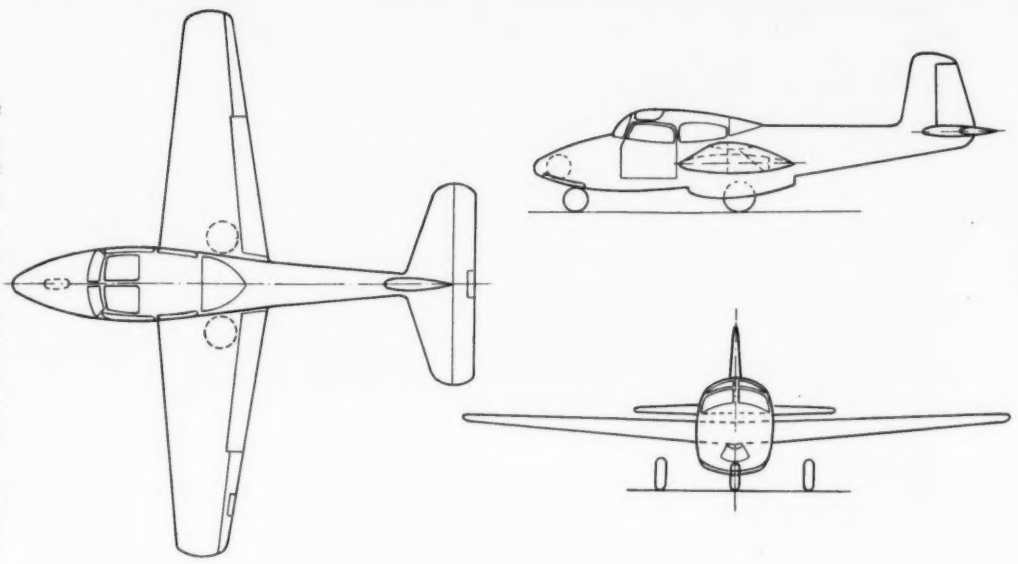
In the meantime, the U.S. Navy has taken a fancy to this development and awarded West Engineering Co. an experimental development contract for a few engines destined to power high-speed remote-controlled missiles. In this way, the company has been able to start off on a business basis, which should facilitate continuation of the project. The engine now costs $2,800, but the designer hopes to market a production model for $1,200.

Let us now take a look at the West light aircraft, which is destined to receive the new jet engine. The two accompanying sketches show this four-seater to be a cantilever all-metal mid-wing monoplane with nose-wheel undercarriage. Worthy of note is the exceptionally small wing area for an aircraft which must certainly have a fairly high gross weight. Intake and exhaust ducts for the turbines are beneath the fuselage. The intention is to run both turbines only for taking-off and climbing, and to cut one out at the cruising altitude of 10,000 to 12,000 feet. Thanks to this substantial reduction in fuel consumption, it should be possible to fly ranges of 450 miles at 250 m.p.h., or 500 miles at 200 m.p.h. Maximum speed with both engines is expected to be 360 m.p.h. at cruising altitude.

The geometric relations are discernible from the three-view line-sketch and the numerical data which follow : —

Dimensions

Span	30 ft. 4 in.
Overall length	25 ft. 8 in.
Height	8 ft. 8 in.
Wing area	140 sq. ft.
Undercarriage track	8 ft. 0 in.
Empennage span	11 ft. 0 in.
Chord at roots	6 ft. 3 in.
Chord at tips	2 ft. 6 in.



The gross weight (at take-off with full tanks) is given as approximately 5,000 lbs. —a figure which appears to be relatively high in view of the fact that the dry weight of the intended turbine is only 180 lbs. But this take-off weight seems justified when one considers the substantial specific fuel consumption, which, according to the manufacturers, amounts to 1.3 lbs. of fuel per 1 lb. of thrust per hour, thus about 520 lbs. or 760 U.S. gallons of kerosene per engine for one hour of maximum thrust. It would therefore be a safe guess that, for a range of 500 miles, with very little reserve fuel, 1,800 lbs. of kerosene will have to be carried, requiring a total tank capacity of 260 U.S. gallons. From this may be assumed the following *weights* : —

Max. take-off weight	5,000 lbs.
Average landing weight	3,700 lbs.
Take-off wing loading	35.7 lb./sq. ft.
Landing wing loading	26.4 - 35.7 lb./sq.ft.

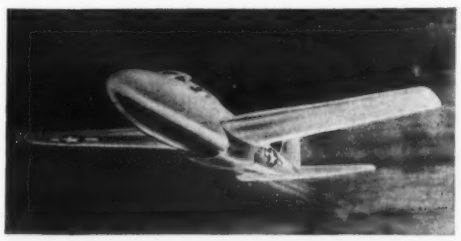
On the basis of an effective maximum thrust of 400 lbs. per turbine, and the aforementioned weights, are calculated the following *performance data* : —

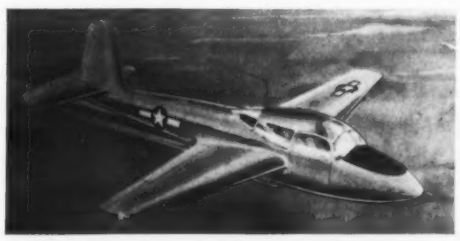
Max. speed on both turbines at approx. 12,000 ft.	360 m.p.h.
Cruise speed on one turbine at approx. 12,000 ft.	200-250 m.p.h.
Range (as per cruise speed)	500-450 miles
Take-off run to clear 50-ft. screen (sea level)	1,800 ft.
Rate of climb (both turbines)	33 ft./sec.

No data are given on the landing speed, but judging from the weights and the wing area, and according to how much fuel is left in the tanks, this may be expected to be between 70 and 80 m.p.h., even with flaps fully extended. For this reason the landing run would not be exactly short either. Thus it will be necessary to fit the aircraft with powerful brakes, seeing that the turbine engines cannot deliver any braking thrust.

Mr. West's project certainly seems very interesting, and perhaps it will soon materialise. One would be quite justified in assuming that such an aircraft could successfully participate in the U.S. National Air Races, for instance, or be used as a trainer for Air Force pilots. But it remains to be seen what kind of a reception it will get from private flyers, for whom it is in reality being built—even if the announced sales price of $7,000 is not overstepped. It must all the same be admitted that the good flight performance is at the penalty of a long take-off run, a high landing speed, and a long landing run. This means long runways. It may not be long before such airfields are available in sufficient number ; but what will the procedure be for an emergency landing ? And what will be the consequences of tyre defects, since it is intended to fit the wheels with only one tyre ? Flying at high speeds is not all pure fun, as many service and test pilots assure us. When " on leave " these gentlemen prefer to fly around in any old biplane than the most modern of jet fighters. And, after all, a private flyer has not the skill of a military pilot. The many comfortably-off business men who have taken up flying will most likely prefer to continue with their safe 200-H.P. aircraft, and fail to be attracted by the 800-H.P. which such jet tourers place at their disposal. And still, *speed* is the order of our day. *Ri.*

For taking off, the projected four-seater high-speed personal aircraft will require 400 lbs. of thrust from each turbine. At cruising altitude, one turbine will be cut out.





A P-80 jet fighter being readied at the take-off end of the Westinghouse " Electropult." The central portion of the track is the twelve-inch-wide secondary core of the wound-out rotor ; the uniformly-spaced projecting elements are the secondary squirrel-cage windings (the primary core and windings are on the underside of the shuttle car). The running wheels fit inside channel-shaped rails, thereby preventing the shuttle car from raising during the acceleration or braking.

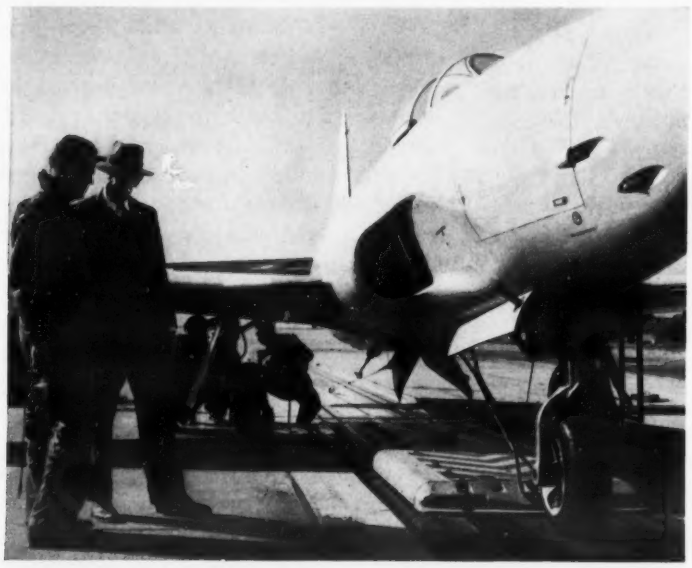
Electropult

This is the name given by Westinghouse Electric Corp. to a new electrically-powered catapult device for launching aircraft, which was developed during the War and intended for use on Pacific atolls. It never came into operation, however, but is now being used by the U.S. Navy at its Patuxent River Base, for test-launching heavily-loaded bombers, jet fighters and pilotless or robot planes.

The main advantage of the " Electropult, " which is basically nothing but a squirrel-cage electric motor of somewhat unusual configuration, is that it enables an acceleration to be built up progressively, thus avoiding the initial jerk common to hydraulic launching systems. Apart from this, its design is not confined to set dimensions and values, but " Electropults " can be built in all sizes and to suit all purposes.

The launching track of the " Electropult " represents the rotor of an induction motor laid out flat, and the shuttle car is actually the stator. The power station is housed in an underground concrete vault beside the launching rails (the latter being flush with the surface of a concrete runway, so that an aircraft can easily taxi across them), and contains a Pratt & Whitney 1,100-horsepower aero engine, driving a 750-kw d-c generator. This power is then taken by a d-c motor, in turn connected to an a-c generator and a 24-ton flywheel. During the relatively short take-off operation, the a-c generator delivers an output of 12,000 kw ; 95 per cent. of this comes from the kinetic energy of the flywheel, and only five per cent. from the engine drive.

Along the 1,382-foot track the shuttle car can attain a speed of 225 m.p.h., so that only in exceptional cases is it necessary to use the entire length. A P-80 " Shooting Star " jet fighter, for instance,



Mr. M. F. Jones, designer of the " Electropult, " explains to Commander E. M. Owen, U.S.N., how the new assisted take-off system works. The shuttle car, only 5½ inches high, is connected by a short towing bridle with the aircraft, while a holdback line is tensioned rearwards. The towing bridle's connecting points with the shuttle car and the aircraft are conceived so as to release automatically once the aircraft's speed is great enough.

The turbo-jet engine is developing full thrust, but the holdback line still restrains the aircraft. Once power is applied to the " Electropult," the pull will be so great as to snap the link around the holdback line, and the shuttle car will whip along the rails.

Airborne ! The shuttle car has reached P-80 take-off speed in 4.1 seconds. With this jet fighter, the shuttle car was braked electrically after travelling only 340 feet ; the towing bridle dropped automatically, allowing the P-80 to shoot skywards at 118 m.p.h. A corner of the shuttle car is visible at the far left of the photo.

Large aircraft can also be launched by the "Electropult." This 28,000-lb. twin-engined bomber (North American B-25H) has been accelerated to 87 m.p.h. in a run of 350 feet.

was brought up to take-off speed (118 m.p.h.) in a 340-foot run in 4.1 seconds.

On the basis of experience gained so far, Westinghouse Corp. have designed an additional "Electropult" for launching large airliners at 120 m.p.h. with a take-off run of 500 feet. Maximum acceleration of 1g is to be built up during the first two seconds of the take-off run. *Bi.*

The underground power station for the "Electropult," showing the control stand for the 1,100-H.P. Pratt & Whitney aero engine (left) and the electrical control stand (right). The "taker-off" is in voice communication with the pilot and watches over the instruments on the panel in the centre of the room.

Copper highways for 12,000 kilowatts of power, running from the power station to the "Electropult" track at the Naval Air Test Center, Patuxent River, Maryland.

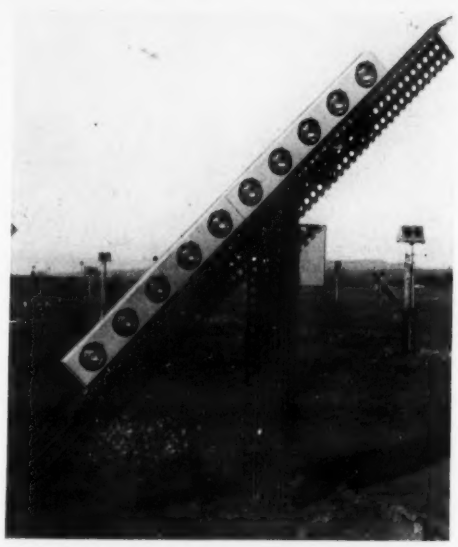
The power station's 24-ton flywheel is spun to 1,300 r.p.m. in eight minutes by the 1,000-H.P. aero engine over a d-c motor. The flywheel's kinetic energy suffices to cause an a-c generator to deliver an output of 12,000 kw for the launching operation, during which time the speed of the flywheel drops at a rate of 42 r.p.m. per second.

The approach path to the instrument-landing runway at the Arcata experimental station is a literal forest of lighting units, all mounted one next to the other, for testing various lighting systems for night and blind landings.

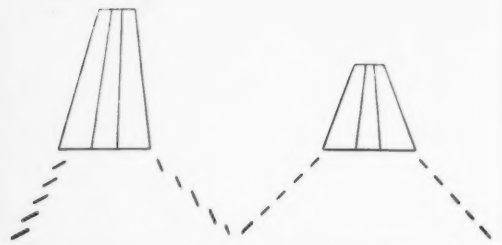
AIRPORT LIGHTING

" The Arcata project for the development of additional visual aids for landing should be continued... " is the recommendation in the March, 1948, report by the U.S. Congressional Aviation Policy Board.

Has the ideal airport lighting system still not yet been found ? Cannot the various airport administrations yet decide on the practical utility of one of the several systems which specialist firms have been manufacturing for a number of years, and which are already installed on many airports ?



Each lighting unit of the new Slope Line Approach System is built up of ten 28-volt aircraft landing lights. It requires 280 kw to power the entire system.



During a correct approach, the separate rows of landing lights form straight lines (left). If the aircraft is not exactly on the glide path, the line will break up into individual light bars (right).

It has long been recognised that the lighting system of an airport must not only indicate to the pilot the location of the runway, but must simultaneously give him sufficient reference aid to enable him to judge the attitude of his aircraft, his position in relation to the prescribed approach path, his altitude, and so forth. During a night approach—presupposing sufficient visibility—a pilot must be able to obtain, from the multiplicity of light sources, those elements which he uses instinctively by day.

A new system for characterising the approach path, which is remarkable for its great simplicity, has been built and tested during the past few months at the Arcata Landing Aids Experiment Station in California.* Known as the Slope Line Approach System, it consists of two rows of 29 lighting units, mounted at intervals of 100 ft. on either side of the approach path. The two rows form a funnel, converging from 430 ft. at the beginning of the approach path to 100 ft. at the runway threshold. Each lighting unit consists of ten 28-volt aircraft landing lights, mounted an eight-foot arm inclined at 45 deg. towards the ground, with the lights directed towards the incoming pilot.

If the pilot is on course and in the proper glide path, the lights are presented as two straight lines bordering the funnel. Depending on how the lines of light may break, on one side or the other of the approach funnel, into separate light bars, the pilot can assess his deviations in altitude or direction.

* Cf. " INTERAVIA, Review of World Aviation," No. 9, Vol. I, P. 50-54.

The pilot has drifted to the left of the centre-line and is a little beneath the glide path. This photo was taken from a point about 2,500 ft. before the runway threshold, o that the pilot still has sufficient time for correcting his attitude.

Good approach : Two uninterrupted converging lines lead towards the runway threshold. The aircraft is on course, but is slightly below the glide path.

Modern Personal Aircraft

This article continues our serial review of present-day aircraft.

A catalogue listing all the personal aircraft in existence today is a fair-sized volume. Although the number of private pilots —especially in Europe—is still extremely small when compared with the number of motorists, there exist almost more makes of light touring aircraft than of automobiles. Whereas airline flight captains only have to pilot about two dozen different types of transport aircraft, private pilots have at their disposal considerably more than a hundred makes, which are powered with about sixty different types of engine.

Understandably, therefore, the average number existing of each make is rather small. The only exception is constituted by a number of American light aircraft—the well-known strut-braced high-wing monoplanes built by Aeronca, Piper, and so forth—and the all-metal constructions. The wide distribution is above all understandable in the case of light-alloy designs, since metal construction is only interesting from the commercial standpoint if carried out on a large scale, and can only be done by larger and well-equipped aircraft firms, which mostly have their own well-developed sales organisations. It is therefore only right if, in this article, we pay more attention to the all-metal types than to the aircraft of wooden and composite structure. This does not mean that the real significance of the latter types should be ignored. These types are suitable for small and medium series, which, despite the extensive amount of manual labour they require, can still be manufactured rather cheaply. And in many countries, the fostering of light aircraft construction, with protective import taxes and Government subsidisation—even in the case of small series—has always been a question of national air pride. And it goes without saying that aircraft of wood and composite structure are more suitable for primary training—and therefore also for less experienced pilots—than the metal types, since they can be repaired more cheaply.

There are all the same twice as many wooden and composite types as metal designs, and this statement is still correct if we disregard the types of which not more than twenty units have been built. An examination of the details, or even a grouping of all characteristics and performance data in the form of long lists of figures, would therefore not be easy to consult, but merely wearying. Thus it is necessary to find another way to present the present-day personal aircraft ; and this we shall do by grouping together everything they have in common, and emphasising the exceptions. In this way it will of course be necessary to leave out many interesting details and exact performance data, but, on the whole, it will make this review easier to consult.

The wider section of the public usually understands a personal aircraft to be a small, light and primarily two-seater aircraft which, equipped with an engine of 40-100 H.P. and a wooden airscrew, is easy to fly and relatively "foolproof" in general, and can also take off and land on small, out-of-the-way airfields. Although this idea is quite correct for a number of types, it has all the same become a little too narrow from the general point of view. This is because the one-time purely sporting aircraft has since developed into a means of aerial transportation, and private aircraft owners today do not only wish to fly for fun, but desire primarily to travel from place to place. And this also means that the modern private pilot wishes to fly *faster* than hitherto, in order to gain time over surface vehicles despite the present large distances between airfields and towns—with the highest possible degree of reliability. For this reason we also find, besides typical light aircraft, faster models with more powerful engines and smaller wing areas—but compensated by flaps—as well as numerous constructions with retractable undercarriage, and even twin-engined types. The open cockpits, which offered such an overdose of fresh air, and often of rain, have practically disappeared. Almost all the modern designs have closed cabins in which the occupants can conduct a conversation without telephonic means and without yelling themselves hoarse. An increasing number of two-seaters are being fitted with night-flying lamps, blind-flying instruments and two-way radio, as well as controllable-pitch or at least metal airscrews. This development is above all noticeable in the U.S.A., where large distances, numerous airfields and the absence of passport, Customs and currency barriers have greatly helped to promote private flying. Around 15,500 personal planes were sold in the U.S.A. during 1947 (even 34,400 were sold in 1946), of which about half were two-seaters. The less fortunate Europeans will of course have to wait a long time before they can compute similar figures.

The easiest way to classify personal aircraft is according to the number of seats they offer :

I. Single-seaters (40-150 H.P.).

II. Two-seaters (40-150 H.P.).

III. Three- to five-seaters (100-300 H.P.).

Of these, the single-seaters form the smallest group from the standpoint of numbers. There exist only about a dozen different designs, of which only four or five are produced serially. Flying seems to be a social type of sport, and for this reason the majority of personal aircraft provide two or more seats. About one third of these are metal types. The engine powers fluctuate between relatively wide limits, with average differences of five and, at the most, ten horsepower. Wider differences only occur in the power classes of over 200 H.P. It will therefore be useful if we start our task of grouping personal planes by tabulating the available aero engines (table I).

Table I. Air-cooled engines for personal aircraft

40-50 H.P.	Mathis 40 H.P. Flat-2 France	CNA 40 H.P. Flat-2 Italy	Praga 45 H.P. Flat-2 Czechoslovakia			Salmson 45 H.P. Radial-9 France
60-70 H.P.	Continental 65 H.P. Flat-4 U.S.A.	Lycoming 65 H.P. Flat-4 U.S.A.	Minié 70 H.P. Flat-4 France	CNA 60 H.P. Flat-4 Italy	Walter "Mikron" 65 H.P. In-line-4 Czechoslovakia	Zlin "Persy" 65 H.P. Flat-4
75-85 H.P.	Continental 75/85 H.P. Flat-4 U.S.A.	Franklin 75/85 H.P. Flat-4 U.S.A.	Mathis 75 H.P. In-line-4 France	Régnier 75 H.P. In-line-4 France	Ambrosini 75 H.P. Flat-4 Italy	Praga 75 H.P. Flat-4 Czechoslovakia
90-105 H.P.	Cirrus "Minor I" 90 H.P. In-line-4 G.B.	Cirrus "Minor II" 100 H.P. In-line-4 G.B.	Nuffield 100 H.P. Flat-4 G.B.	Continental 100 H.P. Flat-6 U.S.A.	Lycoming 100 H.P. Flat-4 U.S.A.	
	Mathis 100 H.P. In-line-4 France	Régnier 100 H.P. In-line-4 France	Walter "Minor 4" 105 H.P. In-line-4 Czechoslovakia	Zlin "Toma 4" 106 H.P. In-line-4		
110-130 H.P.	Continental 115/125 H.P. Flat-6 U.S.A.	Lycoming 125 H.P. Flat-4 U.S.A.	Franklin 130 H.P. Flat-6 U.S.A.	Alfa Romeo 130 H.P. In-line-4 Italy		
140-160 H.P.	D.H. "Gipsy Major 10" 145 H.P. In-line-4 G.B.	D.H. "Gipsy Major 30" 160 H.P. In-line-4 G.B.	Cirrus "Major III" 155 H.P. In-line-4 G.B.	SNECMA Renault 140 H.P. In-line-4 France	Mathis 150 H.P. Vee-8 France	Elizalde 150 H.P. In-line-4 Spain
	Praga 150 H.P. Flat-6	Walter "Minor 6" 160 H.P. In-line-6 Czechoslovakia	Zlin "Toma 6" 155 H.P. In-line-6	Aircooled, Inc. "Franklin" 140/180 H.P. Flat-6 U.S.A.	Svenska Flygmotor 140 H.P. Flat-4 Sweden	Potez 150 H.P. In-line-4 France
* 165-185 H.P.	D.H. "Gipsy Major 50" 180 H.P. In-line-4 G.B.	Continental 165/185 H.P. Flat-6 U.S.A.	Ranger 175 H.P. In-line-6 U.S.A.			
* 190-220 H.P.	D.H. "Gipsy Queen II" 210 H.P. In-line-6 G.B.	Lycoming 190 H.P. Flat-6 U.S.A.	Franklin 215 H.P. Flat-6 U.S.A.	Ranger 200 H.P. In-line-6 U.S.A.	Mathis 210 H.P. Vee-8 France	
* 240-310 H.P.	D.H. "Gipsy Queen 30" 250 H.P. In-line-6 G.B.	D.H. "Gipsy Queen 50" 270 H.P. In-line-6 G.B.	D.H. "Gipsy Queen 70" 305 H.P. In-line-6 G.B.	Lycoming 240 H.P. Flat-6 U.S.A.	SNECMA Renault 240 H.P. In-line-6 France	SNECMA Renault 300 H.P. In-line-6 France
	Continental 240 H.P. Radial-7 U.S.A.	Jacobs 300 H.P. Radial-7 U.S.A.				

* All power data refer to rated power; some engines, however, have a higher take-off power.

TWO-SEATERS

Now that the biplane, despite its former great popularity, has been sacrificed in the interest of greater speeds and has practically disappeared from airfields, there remains, as the most-flown design of typical personal two-seater, the strut-braced high-wing monoplane and, after it, the cantilever low-wing monoplane. Let us begin with the first-mentioned type, which, in view of its constant-chord wing, is usually cheaper and lighter than the cantilever monoplane.

1. *Strut-braced high-wing composite monoplanes.*

The composite-structure field alone comprises thirteen different production types to date, so that there are a great number of units in operation. They are fitted with engines of 65 H.P. or 85/75 H.P., and have fabric-covered wood or metal wing structures, welded steel-tube fuselages, and V-shaped strut-supports. All are equipped with fixed tail-wheel undercarriage. There are no lift-increasing devices, but this is compensated by a landing speed not exceeding 45 m.p.h. In addition to the usual joystick control we frequently find, though only in models with side-by-side seats, the wheel-type of control column. The high-wing monoplanes of composite construction can be classified in the following groups:

65-H.P. Class: Aeronca "Scout," "Chief," "Champion"; Taylorcraft "Twosome"; Piper "Cub Special," "Vagabond" (all U.S.A.). C.A.P. "Paulistinha" and C.N.N.A. HL-1 (Brazil).

85/75-H.P. Class: Aeronca "Champion 85," "Super Chief"; Funk "Bee" (all U.S.A.). Fleet "Canuck" (Canada) and Auster "Arrow" (Great Britain).

This family is represented in Figs. 1 and 2 by two Aeronca aircraft. The "Champion" has two seats in tandem, whereas the equally-powered "Scout"—shown here with floats—seats the pilot and passenger side-by-side. The dimensions, weights and performance data enter within narrow limits for all thirteen types (table II).

Here—and in all the lists of performance data which follow—the cruising speed is not mentioned. As is known, this is dependent on the extent to which the engine is throttled, and amounts to about 90 per cent. of the maximum speed at 75 per cent. rated power and to about 82 per cent. at 60 per cent. rated power. In addition to the widely-marketed types, meanwhile, there are also a few experimental designs, and some that are now no longer in line production. Worthy of mention are the French composite high-wing monoplanes, Aérocentre NC 850, Avianautic RA 14, Lignel 44; the American Commonwealth "Skyranger," Hockaday "Comet," Monocoupe 90, Ross RS-2L; and the Danish Kramme & Zeuthen KZ-III with 100-H.P. engine (distributed by Skandinavisk Aero Industri A/S, Copenhagen). The Danish type, which is no longer produced, differs

Fig. 1: The 65-H.P. Aeronca Champion.

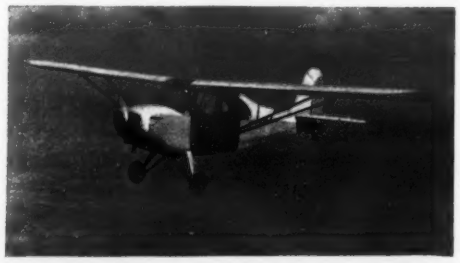


Fig. 2: Float version of the 65-H.P. Aeronca Scout

Table II. Strut-braced high-wing composite monoplanes

Power Class	Span	Wing area	Empty weight	Gross weight	Max. speed	Landing speed	Rate of climb	Service ceiling	Range	Price ex-works
H. P.	ft.	sq.ft.	lbs.	lbs.	m.p.h.	m.p.h.	ft./sec.	ft.	miles	dollars
65	35 to 36	170 to 185	710 to 750	1,200 to 1,280	100	37	8.5 to 10	12,000 to 13,000	250 to 400	2,000 to 2,500
75 to 85	35 to 36	170 to 185	820 to 880	1,350 to 1,450	110	45	10 to 11.5	13,000 to 15,000	250 to 400	2,750 to 3,500

Table III. Strut-braced high-wing metal monoplanes

Aircraft type and engine	Span	Wing area	Empty weight	Gross weight	Max. speed	Landing speed	Rate of climb	Service ceiling	Range	Price ex-works
	ft.	sq.ft.	lbs.	lbs.	m.p.h.	m.p.h	ft./sec.	ft.	miles	dollars
Luscombe "Silvaire 8A" 65-H.P. Continental	35	140	760	1,260	115	45	c.11.5	15,000	300 to 500	(Standard) 2,500 (Special) 2,700
Luscombe "Silvaire 8E" 85-H.P. Continental	35	140	860	1,400	125	50	c.13	16,500	500 to 650	(Master) 3,000 (De Luxe) 3,500
Cessna 120 85-H.P. Continental	32 5/8	159	780	1,450	120	45	11.5	15,500	450	2,850
Cessna 140 85-H.P. Continental	32 5/8	159	860	1,450	120	40 (flaps)	11.5	15,500	450	3,350

The greater empty weight of the Cessna 140, compared with the Model 120, is due to the additional equipment with flaps, batteries, self-starter, night-flying lamps and superior cabin lay-out. It would be still heavier if fitted with a two-way radio, blind-flying instruments, cabin heating and metal airscrew.

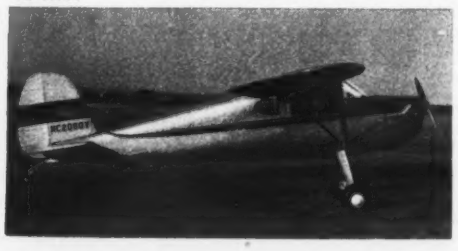
from the others by having a smaller wing area (140 sq. ft.) and lift-increasing devices (flaps and fixed slots) ; with all other data the same, it has a higher maximum speed (115 m.p.h.) than others of the 85-H.P. class.

2. *Strut-braced high-wing metal monoplanes.*

The high-wing metal monoplanes built by Luscombe Airplane Corp. (all-metal) and Cessna Aircraft Co. (with fabric-covered wings) form a group by themselves (cf. Figs. 3 and 4). Apart from the very low empty weights characterising metal constructions, the latter are also noticeable for their aerodynamically-clean configuration and, consequently, their superior speed and climb characteristics to

Fig. 3 : Luscombe Silvaire all-metal high-wing monoplane.

Fig. 4 : 1948 model of the Cessna 140, with a rather more powerful engine (Continental C-90) of 90 H. P.



aircraft of composite design. Worthy of note are the single-leg undercarriages of these two aircraft, and the single-strut supports of the "Luscombe."

3. *Cantilever high-wing monoplanes.*

In addition to the strut-braced designs, there exist a small number of cantilever high-wing monoplanes. The two-seater designs include only wooden or composite structures, thus being either entirely of wood, such as the Macchi MB 308 (Italy) and the Praga "Air-baby" (Czechoslovakia), or fitted with a steel-tube fuselage (Praga E 117). These three types, all of which feature single-section wooden wings to save weight, are shown in Figs. 5 to 7. Characteristics and performance are the same as in Table II—except for the maximum speed, which, in view of the absence of struts and because of the smaller wing areas, is about 15 per cent. higher, *i.e.*, 125 m.p.h. for the Praga E 117 and 115 m.p.h. for the two other types. Both the Macchi MB 308 and Praga E 117 are equipped with flaps. Worthy of notice is the fixed nose-wheel undercarriage of the MB 308, which

Fig. 5 : A successful Italian post-war construction is the Macchi MB 308 (60 H. P., 1,235 lbs., 148 sq. ft.). Price, approx. 15,000 Sw. Frs.

Fig. 7 : The newly-developed Praga E 117 (75 H. P., 1,370 lbs., 159 sq. ft.).

Fig. 8 : The Alaparma, an interesting ultra-light plane of wooden construction.

eliminates bumpy landings and makes the aircraft recommendable for less experienced pilots.

In addition to the types mentioned above, it is possible that a fourth aircraft will be put into line production—the Avia 36 "Bojar" (Czechoslovakia), concerning which details have not yet been released, however. Finally, there is a further prototype which is likely to go into production, the Italian Alaparma AM 10, representing the only cantilever mid-wing monoplane of the two-seater private plane class (Fig. 8). It is remarkable for its very novel light construction (wood, with very few connecting points), the mono-wheel undercarriage with supporting wheels beneath the wing, and the 40-H.P. CNA engine with pusher airscrew. Its empty weight is stated to be only 350 lbs. With a gross weight of 770 lbs. and a wing area of 91 sq. ft. (23-ft. span), a noteworthy performance is attained : maximum speed 100 m.p.h., rate of climb 7.5 ft./sec., and a range of 370 miles.

4. *Composite low-wing monoplanes.*

The low-wing monoplane configuration offers a number of technical advantages. Above all, it allows for a wide-track undercarriage of low structural height, which can be retracted in a very simple manner. Low-wing monoplanes with retractable undercarriage feature very good aerodynamic qualities, resulting in improved speed and climbing

Fig. 6 : Praga Airbaby (65 H. P., 1,210 lbs., 174 sq. ft.). Price, approx. 18,000 Sw. Frs.

qualities. The sturdy wing construction represents a protection to occupants in the case of emergency landings and, finally, it should also be mentioned that visibility in the curve is better than in the case of high-wing monoplanes—above all when curving in to land—since the wing dips out of the field of vision. If we again begin with the wooden and composite types, then we are faced with twelve production models and four prototypes (in parentheses) intended for production. These may be listed in five power classes :

60/70 H.P. Class : Fairey-Tipsy "Belfair," England/Belgium ; Francis Lombardi FL-3 (and FL-5), Italy ; Zlin 22, Czechoslovakia.

75/85 H.P. Class : Sipa S-90, Mauboussin M. 129-48 (and Starck AS-57), France ; (Culver Model V, U.S.A.).

90/105 H.P. Class : C.A.P. "Planalto," Brazil ; Zlin 281, Czechoslovakia ; (Skandinaviska Aero A.B. "Beauty BHT-2," Sweden).

125/130 H.P. Class : Piper "Trainer," U.S.A. ; CNNA "Cauré," Brazil.

140/160 H.P. Class : Fairey-Tipsy "Trainer," Belgium ; Aeronautica Industrial HM-1, Spain ; Kramme & Zeuthen KZ-II, Denmark.

A selection from these types is shown in Figs. 9 to 13. Those developed for real air travel have closed cabins and side-by-side seats, whereas types designed primarily for training purposes mostly have seats in tandem. The latter have either closed cabins (Piper "Trainer," Fairey "Trainer") or, as in the case of the Spanish and Brazilian types, and the Mauboussin M. 129, open cockpits. Only the Culver V has a nose-wheel undercarriage (retractable) ; the other two-seaters have tail-wheel undercarriages, and the only models to have them retractable are the Piper "Trainer" and the Scandinaviska "Beauty." These two aircraft are moreover equipped with controllable pitch airscrews, and are thus endowed with good climbing qualities. Especially high performance is revealed by the "Beauty" with its 90-H.P. Cirrus engine, which, with a gross weight of 1,320 lbs. (695 lbs. empty) and a wing area of 93 sq. ft. (26 ft. span), attains a maximum speed of 160 m.p.h., has a landing speed of 53 m.p.h. (with flaps), and climbs at 15.5 ft./sec. It is of wooden construction and has not yet been put into line production. The data below cover those types at present in serial production (table IV).

An especially good performance is revealed by the wooden Sipa S-90, which last year, in a light-plane design competition organised by the French aeronautical authorities, came first of twelve 75-H.P.-class aircraft. The Zlin 281 corresponds in every detail to the Buecker 181 "Bestmann," the well-known German cabin monoplane of before the War.

Among the prototypes may be mentioned the Guerchais-Roche T-35 with a 140-H.P. engine (France), the Ali-Viberti "Musca-1" with 60 H.P. (Italy) ; two U.S. prototypes in the 100-H.P. class, the Dart Model GC and the Eshelman "Winglet" ; and two U.S. strut-braced monoplanes of 125 H.P., the Call "Callair" and the Rawdon T-1.

5. *Low-wing metal monoplanes.*

Apart from the "Ercoupe," which has fabric-covered wings, all of these—and there are a great many units flying—have metal-skinned wings and thus come in the all-metal category. The nose-wheel undercarriage has almost become standard equipment, as only

Table IV. Cantilever low-wing composite monoplanes

Power class	Span	Wing area	Empty weight	Gross weight	Max. speed	Landing speed	Rate of climb	Service ceiling	Range	Price ex-works
H.P.	ft.	sq.ft.	lbs.	lbs.	m.p.h.	m.p.h.	ft./sec.	ft.	miles	Sw. Frs. *
60 to 70	33 to 36	130 to 155	710 to 820	1,100 to 1,300	110 to 115	40	8.5 to 10	11,500 to 13,000	300 to 500	14,000 to 22,000
75 (Sipa S-90)	29	125	860	1,370	120	45 (flaps)	8.5	14,000	320	*c.* 13,000
105 (Zlin 281)	35	145	1,050	1,760	125	45 (flaps)	10	12,500	560	*c.* 30,000
130 (Piper "Trainer")	36 1/4	178	1,325	2,000	150	50	*c.* 16.5 (c.p. airscrew)	*c.* 19,500	700	
140 to 160	30 to 33	145 to 160	1,190 to 1,370	1,870	135 to 150	45 (flaps)	13 to 15	16,500	400 to 500	

* Exchange value of Sw. Frs. 1 = Fr. Frs. 76.

Fig. 9 : Tipsy Belfair (65 H. P., 1,100 lbs., 130 sq. ft., wooden construction).

Fig. 10 : The Sipa S-90, which won the French light plane competition in 1947 (75 H. P., 1,370 lbs., 125 sq. ft., wooden construction).

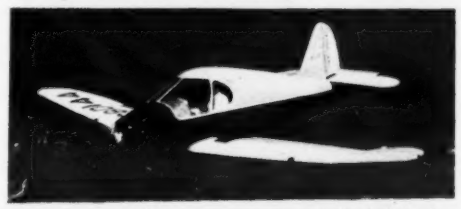


Fig. 11 : A Culver V over New York (85 H. P., 1,600 lbs., 126 sq. ft.). Wooden construction, retractable nose-wheel undercarriage, flaps, Simplyfly control, and bent-up wing tips.

Fig. 12 : Zlin 281 (106 H. P., 1,765 lbs, 145 sq. ft., composite structure).

Fig. 13 : Fairey Trainer (145 H. P., 1,830 lbs., 154 sq., ft., composite structure).

Fig. 14 : Thorp Sky Skooter (65 H. P., 1,050 lbs., 140 sq. ft.).

Fig. 15 : ERCO Ercoupe (85/75 H. P., 1,400 lbs., 143 sq. ft.).

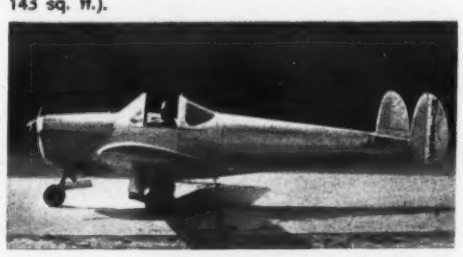


Fig. 17 : Swift 125 (125 H. P., 1,710 lbs., 132 sq. ft.).

Fig. 16 : Aero Flight Streak 85 (85 H. P., 1,400 lbs., c. 91 sq. ft.).

Table V. Cantilever metal monoplanes

Aircraft type	Engine	c. p. airscrew	Flaps	Under-carriage	Span	Wing area	Empty weight	Gross weight	Max. speed	Landing speed	Rate of climb	Service ceiling	Range	Price ex-works
					ft.	s2. ft.	lbs.	lbs.	m. p. h.	m. p. h.	ft./sec.	ft.	miles	dollars
Thorp "Sky Skooter" U.S.A.	65-H.P. Lycoming	—	—	Nose-wheel fixed	25	*c.* 140	560	1,050	115	45	10	12,000	400	2,700
Engineering & Research Corp. Model E "Ercoupe" U.S.A.	85-H.P. Continental	—	—	Nose-wheel fixed	30	143	815	1,400	125	50	10	11,000	450	3,450
Aeronca "Chum" U.S.A.	85-H.P. Continental	—	—	Nose-wheel fixed	28 3/8	140	860	1.400	120	50	10	11,000	400	not yet in production
All American Aircraft "Ensign" U.S.A.	85-H.P. Continental	—	—	Nose-wheel fixed	32 11/12	140	1,000	1,550	125	53	11.5	12,000	400	3,500
Aero-Flight "Streak" U.S.A.	85-H.P. Continental	+	+	Nose-wheel retr.	25 1/4	*c.* 91	850	1,400	175	53 +	15.5 +	17,000 +	750	(3,750) not yet in production
Texas Engineering Co. "Swift 125" U.S.A.	125-H.P. Continental	+	+	Tail-wheel retr.	29 1/8	132	1,140	1,710	150	50 +	16.5 +	16,000 +	510	3,500
De Havilland "Chipmunk" Canada	145-H.P. 'Gipsy Major10'	— (+)	+	Tail-wheel fixed	34 1/3	173	1,175	1,800 to 1,900	145	40 to 43	15	19,000 to 21,000	480	7,950
Morane-Saulnier MS-570 France	140-H.P. Renault	+	+	Nose-wheel retr.	34 1/3	174	1,490	2,080	160	50 +	14 5 +	19,500 +	710	
Max Holste MH-52 France	150-H.P. Potez	—	+	Nose-wheel fixed	32 1/12	150	1,410	1,920	150	*c.* 50 +	14.5	*c.* 16,500	*c.* 430	

Fig. 18 : Aeronca Chum (85 H. P., 1,400 lbs., 140 sq. ft.).

Fig. 19 : The Chipmunk trainer, built by The de Havilland Aircraft of Canada, Ltd. (145 H. P., 1,900 lbs., 173 sq. ft.).

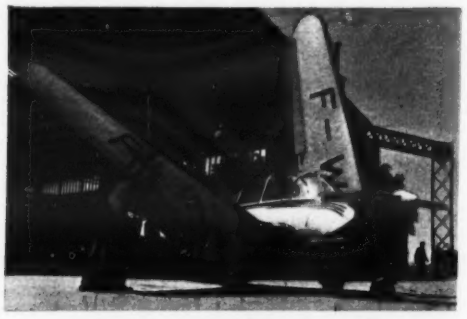


Fig. 20 : Morane-Saulnier MS-570 with folding wings (140 H. P., 2,080 lbs., 174 sq. ft.).

the "Swift" Model 125 and the "Chipmunk" are still fitted with tail-wheel undercarriage. Three of the nine makes mentioned here have retractable undercarriage and five have lift-increasing devices. Except for the "Chipmunk" trainer, which has seats in tandem (and a covered cockpit), all have side-by-side seats. The "Ercoupe" and "Chum" are remarkable for a simplified control system, developed by Engineering & Research Corp., which provides a single wheel-type column for simultaneous control of all the surfaces, and is stated to be quite foolproof. This means that the usual rudder pedals are eliminated, but it is doubtful whether this arrangement, which of course eliminates side slip, will find general acceptance. Table V lists the performance data and characteristics of these types, and Figs. 14-21 present them pictorially. The title photo shows the "Swift" Model 125, which has a Continental engine and controllable-pitch airscrew, and, though developed by Globe Aircraft Corp., is now being built by Texas Engineering Co.

Apart from the production types there are again quite a few prototypes flying around, whose serial production has not yet been decided. In this connection we shall mention the 75-H.P. prototype of the French SNCA du Sud-Ouest, which can be fitted with either a nose-wheel (SO 7050) or with a tail-wheel (SO 7055) ; the SO 3050 fitted with nose-wheel undercarriage and a 145 H.P. Renault engine, built by the same firm ; and the American 125-H.P. Meyers MAC-125 two-seater, which corresponds roughly to the Texas-Swift 125 ; and then the 85-H.P. Aeronca "Arrow" with retractable tail-wheel undercarriage. There is also the British Essex Aero "Sprite," fitted with a 100-H.P. Nuffield engine, which is to be built entirely of magnesium alloy (nose-wheel undercarriage, either fixed or retractable ; butterfly empennage). An extremely interesting design originating from America is the 75-H.P. "Jaybird," by Volmer S. Jensen (Fig. 22), which looks a little like a sailplane with auxiliary engine, and reveals a very good performance. In conclusion, mention should also be made of the *twin-engined* Hodek HK-101 two-seater prototype (Czechoslovakia), powered with two 105-H.P. Walter engines, although it seems unlikely that it will remain in its present two-seater form (maximum speed 220 m.p.h. ; Fig. 23).

This terminates our presentation of two-seaters, in which 39 production types and 30 prototypes have been mentioned. In subsequent issues of "Interavia," the multi-seater touring aircraft and finally the single-seater light planes will be presented to readers.

Ri.

Fig. 21 : Max Holste MH-52 (95/150 H. P., 1,920 lbs., 150 sq. ft.).

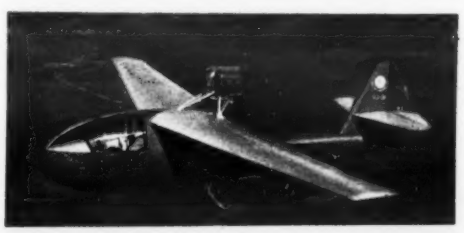
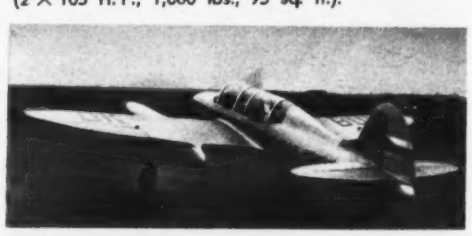


Fig. 22 : Volmer Jensen Jaybird (75 H. P., 1,340 lbs., 158 sq. ft.).

Fig. 23 : Hodek HK-101 twin-engined two-seater (2 × 105 H. P., 1,800 lbs., 93 sq. ft.).



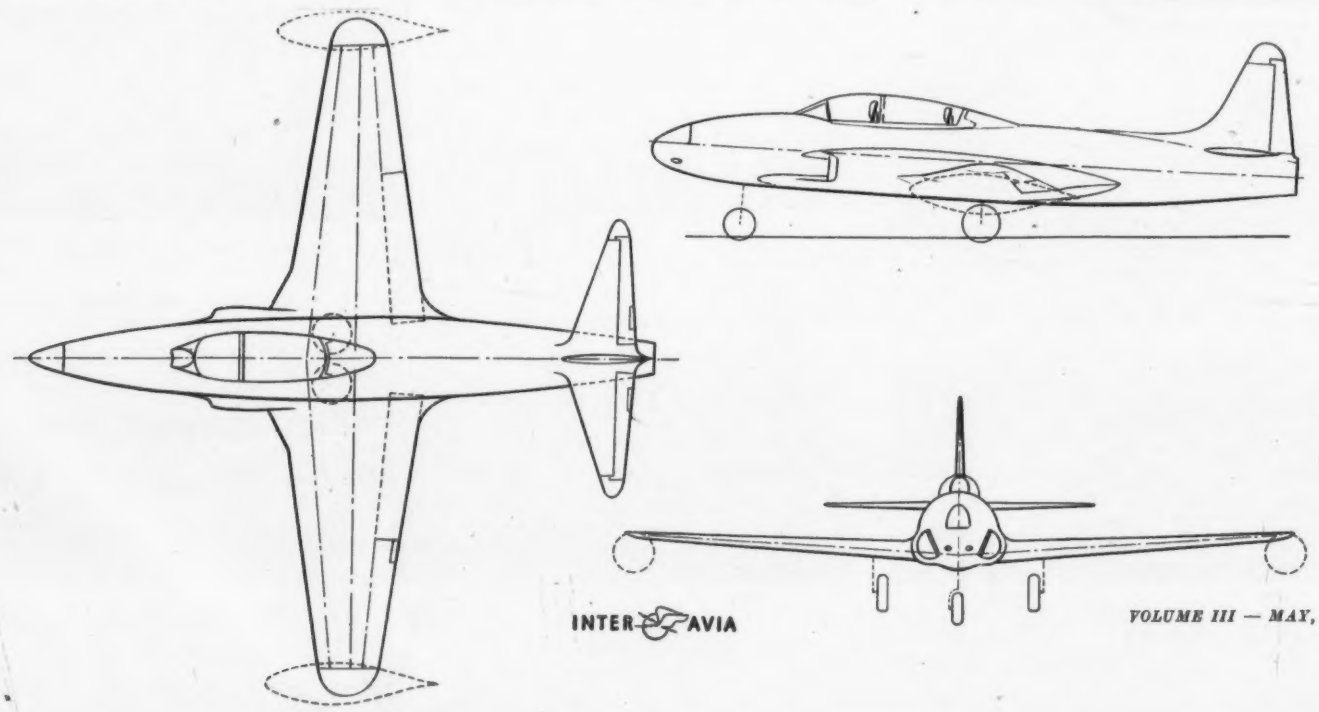
THE LOCKHEED TF-80C TWO-SEATER CONVERSION TRAINER, visible in the foreground, features a span of 37 ft. 8 3/5 in. and is only 38 inches longer than the standard P-80 "Shooting Star" (in the background).

TF-80 C

The New Lockheed Jet Conversion Trainer

The training of fighter pilots has always been a task which is as important as it is difficult. Conversion and advanced-training aircraft with flight performance and characteristics closely approaching those of standard fighters, were usually single-seaters. But the training of front-line pilots could also proceed progressively, by passing gradually from simple to complicated aircraft, and the fact remained that the engine servicing of the standard single-seater fighter did not place any greater demand on pilots than that of the training aircraft.

With the advent of modern jet fighters, a new situation has arisen since the end of the War. The gap between trainers and combat aircraft has been widened. Maximum speeds had quickly been stepped up to very near the 1,000 kilometres-per-hour-limit, and the compressibility effects, which had so far only occurred in speed record flights, started making themselves increasingly noticeable. Since these disturbances usually occur with extreme suddenness, they have sealed the fate of many an unexperienced pilot. Apart from this, aircraft gas turbines require careful servicing, for even though jet propulsion offers indisputable advantages, it



all the same possesses peculiarities which, if not heeded, can entail serious consequences.

The immediate task was therefore to provide two-seater training aircraft whose mode of propulsion, flight performance and general characteristics came as near as possible to those of a high-performance fighter. It was with this thought in mind that the French proposed the two-seater SO 6000, a project which was exhibited at the Paris Salon as long ago as 1946, but for various reasons has so far not been put into operation.

In the U.S.A. these problems are still more acute than in France, as the U.S. aircraft industry is continually delivering various types of jet fighter to the armed forces. Lockheed Aircraft Corp., manufacturers of the P-80 "Shooting Star," a jet fighter famed for having broken the world speed record, have now developed a *two-seater version of the P-80*. Known as the *TF-80C* (TF standing for trainer, fighter), it uses exactly the same wing as the single seater and is powered by the biggest jet engine now available in the U.S.A., the Allison Model 400 C-5. With water-methanol injection, this engine delivers a peak thrust of 5,400 lbs. and a normal thrust of 3,600 lbs.

Owing to the installation of the second pilot's seat, the fuselage length has been increased by 38 inches. Both seats are covered by the same upwards-opening canopy and can be shot out of the aircraft individually. With additional fuel tanks at the wing tips, bringing the entire fuel supply up to 700 U.S. Galls., the all-up weight of the TF-80C is 14,440 lbs. ; empty weight is 8,080 lbs.

Use of this new jet trainer is expected to eliminate one entire step of normal fighter training, and it is expected in the Air Force that it will save between ten and fifteen per cent. of the present cost of training each pilot. So that it can also serve for gunnery instruction, two machine guns are mounted in the nose ; but it is not difficult to modify the armament so as to give the TF-80C the full firepower of the standard P-80. No information has yet been disclosed on the new jet trainer's flight performance, though it is probable that this will not be very much inferior to the standard "Shooting Star." *Bi.*

Air view of Shannon International Airport, Ireland. The entire dammed-up area containing the runways is customs-free.

Customs Officials No Entry!

Customs-Free Airports

I. "RETRO-PROGRESS" OF INTERNATIONAL GOODS-EXCHANGE

National economy teaches us that in the Middle Ages the bulk of commerce took place within the national frontiers. International trade hardly existed. But Customs duties and Customs officials have always existed — "for which we are truly unthankful!" And the olden methods had nothing to learn from our present excise machinery, either. Take a look at the duties decreed in 1363 and 1370 by the Schaffhausen "Salzhof" — Salt Court — which show that even in those days officialdom was well versed in the art of making vitally-essential commodities more expensive; the translation would look something like this:

ye heavye cartt with bleached salte	6 angsters
ye barelle of salte	3 angsters
ye quintal of copper	1 stebler
ye cartt with wyne with thre roans	3 angsters
ye cartt with wyne with two roans	2 angsters
ye cartt with doublets	8 angsters

It is plain to see that, of old as today, this type of "tribute to Caesar" played a weighty part. But in contrast to modern customs administration, we are forced to admit that the Customs officials of the dim Middle Ages were very much conscious of the general usefulness of trade and traffic, and that they were shrewd enough to spot the value to their own countries of transit trade. The same list of duties continues with:

ye tonne of heringges solde here	2 angsters
ye tonne of heringges going thro	1 angster

We can't tell you offhand what an angster was worth, but it can be seen from the above that goods in transit were taxed for only half the amount imposed on goods imported; and other ancient documents show that goods in transit were sometimes even allowed to go duty-free. Gadswounds, man, those were Ye Dayes!

And now to take a more modern example — after over five centuries of "progress." A few years before World War I, when it was discovered that a rich and valuable oil could be extracted from soya beans, French industrialists thought they could monopolise the refining process. They started plans for importing soya beans, processing them, and exporting the oil as soon as possible. But they forgot all about the French Customs when they drew up these plans, and, to their dismay they saw a vegetable import duty clamped down on soya, amounting to three francs a hundred kilos. It goes without saying that this tax was not commensurate with the ten per cent. oil contents of the beans. Not a penny did the industry make in profits. Soya remained dutiable in France, and the result was that the bulk of the refining industry passed from France to Bremen and Liverpool, where 500,000 tons of oil were soon being extracted annually, and exported at a high profit to various countries, including France. — The Customs might put this story down on the records!

Since the Customs have refused to alter their principles in nearly six centuries, it is hardly conceivable that they should be specially impressed by the advent of air transport.

On the shores of the Mediterranean is an old country, rich in culture and tradition, which, for convenience, we shall call Ophir. Commercially, it is very dependent on foreign trade and goods in transit. But does the Customs administration yield an inch to the advantage of the national interests of Ophir? Not on your life! Airline passengers in transit have to pay duty on every single dutiable item they possess, even if they are only staying within the airfield limits for about thirty minutes. There are special Customs sheds for transit passengers and a tax amounting to 50 units of Ophirian currency has to be paid out for the checking of each item of luggage, whether dutiable or duty-free. And the same country wishes to encourage foreign tourists.

Everybody connected with aviation can tell you that one of the main achievements of Customs administrations has been to hinder civil air transport. We shall not give any further examples, in case anyone might gather the impression that such episodes only happen at certain times and certain places. In reality, Customs procedures have always been monotonous in their unvaried hampering of commerce.

II. FREE PORTS

One weapon which commerce has used for centuries in its fight against protectionism and its struggle to liven up the exchange of goods, is the free port. The first modern free port to be established, that at Livorno, in 1547, became an important emporium and gateway to the Levant. The example was copied in Genoa in 1599, Naples in 1633, Venice in 1661, and later in Ancona and Messina. In France, Louis XIV's finance minister, Colbert, made Marseilles a free port after the edict of March 26th, 1669. Austro-Hungary later established free ports at Trieste and Fiume, and other European countries were quick to follow.

In contrast to protectionist countries, Great Britain had no need for free ports in those days. All of Britain was a "customs-free zone," which was very advantageous. Only overseas did the British establish free ports — at Hong Kong, Singapore, Penang. At home they developed the warehousing system—like in America—where imported goods can be stored pending their domestic distribution or re-exportation (eventually after processing or re-packing).

As international trade was streamlined and frontiers opened up, other countries began introducing the British warehousing system. One after the other, sea-ports were deprived of their free-port privileges.

But today, in the age of civil air transport, frontiers are being sealed up more hermetically than ever. Instead of finding advantages in the increased speed of this newest means of transportation, exporters, importers and carrier concerns are having to fight hard to keep up a bare existence.

The concept of the *Customs-Free Airport*, the answer to these difficulties, was first put into practice by a country which is dependant more than any other on smooth air transit operations: Ireland.

III. SHANNON

Since the earliest beginnings of the Provisional International Civil Aviation Organisation, PICAO, the Irish have urged the establishment and international recognition of "Customs-Free Zones." Their argument is well worth reading:

> "... The development of air traffic, with its emphasis on speed, has made more noticeable the delays occasioned by the restrictions that are everywhere imposed on international travel. The elaborate requirements of Customs are tolerable in the case of surface transport, as the time occupied is only a small part of the total time taken on any journey. In the case of air traffic, however, such formalities take up a considerable proportion of the travelling time, not only at terminals, but at immediate stops. Such delays are irksome to passengers and result in the immobilisation of aircraft for periods which in the aggregate are substantial."

The Irish were not content to bandy words. Their blarney blossomed into deeds, and the "Customs-Free Airport Act" was passed in 1947, establishing such a zone at Shannon. The urgency of this measure becomes all the more apparent from the airport's statistics, which reveal that 84 per cent. of the passengers at Shannon during 1947 were in transit, and that 92.5 per cent. of the freight, excess baggage and mail was in transit.

Traffic at Shannon Airport in 1946.

Arrivals and departures	8,432	
Total passengers	95,705	
in transit	81,223	(85 %)
domestic traffic	12,326	
Total freight, excess baggage and mail	1,913,960	kgs.
in transit	1,839,911	kgs. (96 %)
domestic traffic	23,317	kgs.

Traffic at Shannon Airport in 1947.

Arrivals and departures	12,957	
Total passengers	149,777	
in transit	125,834	(84 %)
domestic traffic	12,145	
Total freight, excess baggage and mail	3,833,592	kgs.
in transit	3,545,629	kgs. (92.5 %)
domestic traffic	105,752	kgs.

As can be seen from the plan, the Customs-free zone occupies the greater part of Shannon airport, whilst the Customs area is confined to a few rooms of the administration building. Article 4 of the Customs-Free Airport Act makes the *entire airport area at Shannon a neutral zone,* placed outside the Irish Customs limits:

> *"The laws for the time being in force relating to the importation and exportation of goods shall not apply to the bringing of goods directly into and out of the airport from and to countries outside the State, except in so far as these laws are applied by regulations made under this Act."*

Until they have been examined by the Customs prior to being distributed within the country, or until they have been loaded for carriage to another country, goods remain in storage within the boundaries of the free airport. Transit passengers are exempt from the Customs examination, and those delayed overnight are accommodated in hostels situated within the free airport. And it is worth emphasising that these friendly regulations are not subject to limitation or cancellation because of any "exceptional circumstances," as one might tend to suspect. The only prohibitive regulations concern public health laws relating to dangerous drugs and diseases; and the usual currency restrictions have to be enforced. Then, of course, there is a control at the free airport boundary to prevent the establishment of a cheap market for perfume, chocolates, tobacco, and so forth, which might be too great a temptation for the Colleens of nearby Limerick.

* * *

For the time being, *Shannon is the only customs-free airport in existence,* though efforts to establish similar free zones are being pursued by several major airport authorities in Europe and other continents. In the U. S. A., for instance, "free trade zones" are attached to the seaports of New York, New Orleans and, since recently, Los Angeles. It may be taken for certain that these zones will later be attached to the airports of these three cities.

IV. "STREETS PAVED WITH GOLD"

A stroll through the storage facilities of a customs-free zone is truly impressive. Ten thousands of sacks of wheat, maize, cattle fodder; bales of tobacco, barrels of wine, cases of fruit, piles of iron, zinc and copper goods, originating from all over the world, met our eyes. In a corner, standing next to a crate destined for Dakar, we were startled to see a gigantic bronze statue of a cow, which had come from India. Straight away we asked what these massive commodities had to do with aviation. By way of an answer, our guide beckoned to us to follow him. Round a corner was another door, and above it a notice board bearing the inscription "Air Freight." We went through it into a room which was no greater in floor area than a medium-sized house. But the guide assured us that its contents were worth far more than all that was in the other, larger store rooms, through which two railway tracks ran. We saw that the majority of the goods were valuables or perishable commodities: watches, furs, jewelry, precision instruments, chemicals, flowers, fruit, and so forth; which lend themselves to transport by air.

Precisely the values of these commodities show the advantages of a free port. It is not only to the benefit of transit traffic by allowing this to go customs-free. Without free ports, many importation concerns could not make both ends meet, financially, since it often happens that such a concern has not the necessary cash in hand to pay immediately the duty on the full load. In this way, the importer can take out just as much as he can afford to pay duty on, and leave the rest in storage; or even use his goods as a collateral for a loan.

In view of the Customs restrictions now existing all over the world, it is evident that the Customs-free airport is destined to play a significant part in the development of civil air transport. In line with this concept, the IATA Government Forms Sub-Committee, at its meeting in London last March, recommended the establishment of free zones through which transit passengers could pass without visa or passport for the country concerned; and a similar establishment of free trade zones for freight transport.

We would point out to all who are apt to criticise or doubt the value of such zones, that throughout the history of commerce — with all its crises and collapses — never has there been an instance of a free port having to close down because of financial difficulties.

Map of Shannon Customs-Free Airport. The outer limit of the Customs-free zone is marked by the thick black line and lettered A, B, C, D, E, F, G. The customs area is confined to the shaded portion of the administration building.

C 2228 a/D IV

I. CHRONIC FORMULARITIS

As soon as the summer season comes around again, the newspapers carry reports that aircraft are being attacked by eagles, vultures and falcons, and very nearly brought to disaster. But without conducting any very deep investigation into the question, we can assure you that our feathered friends and foes are far less dangerous to aeroplanes than secretaries are. It is not the bird of prey which constitutes the main menace to aviation, but the ultra-bureaucratic officials who, all over the world, are threatening to suffocate it beneath mountains of paper.

On May 17th, 1948, the Facilitation Division of the ICAO Air Transport Committee will meet in Geneva in order again to do battle with the formula-and-formality monster. For the present, the strongest battalions are undoubtedly pledged to the flag of officialdom. When the International Air Transport Association met last autumn in Rio de Janeiro, nineteen persons travelling there from Montreal had to secure 299 documents bearing 606 seals and rubber stamps and 900 signatures in order to make the trip. The then President-Elect of IATA, Dr. M.J. Bento Ribeiro Dantas, President of Panair do Brasil, asserted that Brazil's tourist potential is enormous, but that the laws and regulations had not encouraged the tourist. And Sir William P. Hildred, Director-General of IATA, added to this the following words :

> "International air transport can multiply the tourist trade many times, but only if air travellers are permitted to take full advantage of its great speed and convenience. The accumulation of red tape around air travel is like a beaver dam, full of sticks and straws and bureaucratic mud, behind which the stream of tourists is imprisoned."

II. RED TAPE ACROSS OUR OWN LETTER BOX

Scandinavian Airlines System sent us on December 4th, 1947, from Stockholm their "Passenger Handbook"—a handsome, blue-bound, foolscap file. Easily detachable pages contain all that is worth knowing about flying by SAS. As a matter of course, the Handbook was sent to us by airmail, and likewise as a matter of course, we received it a month later, on January 5th, 1948. Not a word was said about this gap of one month between the date of despatch and the date of receipt. But what caused us really to shake our heads in disapproval was the amount of red tape characterising its delivery. The Handbook was accompanied by twelve—yes twelve—delivery documents, with a total of twenty seals, as well as seventeen signatures. There were four copies of the air waybill : copy No. 2 is marked "For Consignee," copy No. 3 "For Issuing Company," No. 4 "For First Carrier." No. 8 is marked "Memorandum Copy." Copies 1, 5, 6 and 7 did not reach us. Presumably they have been filed in official offices along the route. Then there were six copies of a pro forma invoice :

> "Scandinavian Airlines System
> Pro forma invoice
> December 4, 1947
> Sent you today per Service II
> 1 parcel gross weight 2 lbs.
> Interavia,
> 6, rue Corraterie,
> Geneva.
>
> Contents :
>
> 1 SAS Passenger Handbook à Sw. Cr. 3.— (3.— no charges N.C.V.).
>
> Scandinavian Airlines System
> Signature."

Six times ! The airline company surely did not make out six copies just for the fun of it, and it is probable that it had to make out even more than six. One or the other of these is probably also lying in some official file.

Documents 11 and 12 comprise a Swiss Customs receipt for Frs. 1.90, according to tariff 340B, and a sales tax receipt for Frs. 0.70. The officials calculated Frs. 4 as the value of the despatch, which means that Frs. 4 are burdened with Frs. 2.60 in official costs.

III. WAGERS TAKEN ON

The SAS Handbook comprises 88 pages. Forty-two pages refer to Customs, passports and visa regulations, and formalities concerning entry, departure and transit. The departure formalities for trans-Atlantic passengers begin on an ominous note :

> "Before departure all trans-Atlantic passengers are requested to make a final check-in in order to have their documents controlled. Passengers must arrive at the check-in places and at airports at times prescribed by SAS to permit the completion of Governmental and other procedures."

And then the game really starts : Innoculation certificate for smallpox, made out at least two weeks and at most three years before the date of arrival ; proof of funds in the form of an affadavit of support sworn before a U.S. Notary Public ; temporary visitors must present a return ticket or proof that they will obtain one ; permanent residents should have proof of funds to support them while in the U.S. ; $8 head tax on behalf of every alien staying over 60 days ; prospective husbands must deposit a $500 bond with the U.S. Immigration Authorities before their future wives can arrive in the U.S.A. ; persons seeking entrance to the U.S.A. for medical treatment must deposit $500 with the U.S. Immigration Authorities ; travellers to Portugal should have their passports stamped by the Policia Internacional in Lisbon within 48 hours after arrival (it is comforting to learn that this is not applicable to persons staying less than 24 hours). In addition to a police certificate of good conduct, passengers to South America are advised to have at least 35 passport photos.

The section on passenger service gives a glimpse into the joys awaiting airline passengers : breakfast, lunch, dinner, "Smögasbricka," cocktails or schnapps, checker, chess and cribbage sets, playing cards, poker chips and dice. Other remembered items are : aspirin, bromo-seltzer, Midol . . . probably for those who have forgotten some of the papers mentioned above.

* * *

The Facilitation Division will have its hands pretty full when it comes to Geneva. In June, 1946, it submitted to the ICAO member countries a memorandum which proposed, in addition to a standardisation of aircraft documents, a uniform and internationally-valid identity card for transit passengers. Of all these recommendations, little has been done so far in the way of action. Meanwhile, however, well towards the top of the agenda of this month's meeting are still the following items :

> Entry and clearance of aircraft and traffic ;
> Handling of embarking and disembarking traffic ;
> Passports, visas and immigration procedures generally ;
> Customs procedures ;
> Public health procedures, including quarantine, sanitation and vaccination ;
> Agricultural procedures, including plant and animal quarantine ;
> Currency exchange facilities.

The Government Forms Sub-Committee of IATA, which met in London last March, has already prepared a comprehensive dream-list for the benefit of the ICAO delegates when they come to Geneva. Representing the views of Committee Members from 67 scheduled airlines and 43 nations, under the chairmanship of Mr. H.H. Galbraith (PAA), it states :

> "The prime object of proposing facilities for air passengers is to make travel from one Continent to another as simple as it is now between two towns in one country."

What are the odds that it will still take quite a long time ? *He.*

Economic Aspects of the American Aviation Industry

VIII *

Statistics for the sixteen domestic trunk airlines for December, 1947, and for the full year of 1947 compared with 1946, were recently released by the U.S. Civil Aeronautics Board.

	1 month ending		12 months ending	
	Dec. 31 1947	Dec. 31 1946	Dec. 31 1947	Dec. 31 1946
Revenue Miles Flown ..	24,599,188	26,940,971	311,879,430	304,544,012
Revenue Passenger Miles (in thousands) .	432,548	503,479	6,010,627	5,903,111
U.S. Mail Ton-Miles ...	3,687,747	3,456,722	32,878,825	32,867,976
Express Ton-Miles.....	3,281,007	3,522,272	28,533,362	23,651,666
Freight Ton-Miles	4,712,246	2,798,279	35,213,590	14,433,101
Revenue Passenger Load Factor	59.70	68.27	65.67	78.81

These figures are quite revealing of the troubles of domestic airlines. Approximately a year ago, the industry was generally anticipating gains in revenue passenger miles for 1947 of some 20 per cent. over 1946. Early months of 1947 gave promise that these estimates would be fulfilled. However, the closing months of 1947, complicated by the grounding of the DC-6, were poor and the decline in revenue passenger miles for December, 1947, of approximately 1 per cent. compared with the previous year, was a disappointing showing. Domestic load factors have been averaging below 60 per cent. in recent months, a rate at which none of the major airlines are able to show profits. In January and February some of the smaller airlines have been reporting load factors of under 50 per cent., at which level losses have been large in spite of renewed economy drives all through the industry.

Of the annual reports so far released by principal domestic airlines the United Air Lines report is particularly worth comment. The company's total operating revenues were $69,000,000 for the year, an increase of about $4 million. Operating expenses, however, of nearly $74,000,000, were up some $11,000,000 from the previous year. The largest percentage increase was in depreciation, which totalled nearly $8,000,000, compared with moderately over $5,000,000 in 1946. As a result, the company showed a net loss from operations of $4,800,000, compared with a net profit of $2,500,000. After other deductions and the credit resulting from the carry-back of Federal Income Taxes, the final net loss was $3,774,000, or $2.19 per share on the common stock, compared with a net income for 1946 of $1,087,000, equivalent to 54 cents per share.

The United Air Lines balance sheet at the end of 1947 showed an improved working capital position, amounting to about $7,000,000 as compared with only $2,000,000 at the end of the previous year. Debts, however, amounted to nearly $33,000,000, compared with nothing the year before; and there was also outstanding somewhat over $9,000,000 of preferred stock issued in 1947. Common stock capitalisation remained the same, but earned surplus was only $2,452,000, compared with $11,300,000 the year before. Because of the restricted financial position, the company has recommended to stockholders an increase in the authorised capital stock for the purpose of raising additional capital funds when market conditions justify.

Recent checks with the United Air Lines management indicate that through the middle of March passenger revenues were making unfavourable comparisons with a year ago, in spite of fare increases amounting to approximately 20 per cent. The return over the next few months, at an accelerating rate, of DC-6 equipment to service, it is hoped, will result in increased passenger traffic. Earlier estimates of traffic volume for 1948, however, are being revised downward. Meanwhile, in the face of these disappointing results, the United Air Lines stock and stocks of other airlines have been moving up—proving, once again, that the financial community pays little attention to current results and pays primary attention to forecasting possible results six months or more ahead. The main reasons for the improving sentiment towards airlines stocks are perhaps that, seasonally, the airline industry is coming into the good portion of the year and also many individuals foresee a programme in which the airline industry, as an important factor of U.S. National Defence, will receive much needed government aid.

The American Airlines report for 1947, recently released, shows a very similar trend to that of United Air Lines, with revenues at a new high but a net loss of $2,960,000 after carry-back tax refunds. The American Airlines management has estimated a net income of $4,000,000 to $5,000,000 for 1948, which is somewhat more optimistic than the public statements of other airline managements. However, some clue to the probable action of the C.A.B. on pending application for increased mail pay is now available in the National Airlines mail-pay decision, which will approximately quadruple this airline's mail revenues in 1948. In this decision the C.A.B. awarded National a lump sum of $545,000 for carrying the mail between July 14 and December 31, 1947. This amounted to about $400,000 more than National would have received under the old rate. The importance of this decision is twofold. First, it is concrete evidence that the airlines are going to receive substantial additional mail pay and that, in part, the claims for retroactive mail pay may be honoured. Second, the method of computing mail pay is still on a ton-mile basis, National receiving 60 cents per ton-mile, but the Board has approved a "phantom" mail load of 350 lbs.

* Cf. VII in "Interavia, Review of World Aviation," No. 1. January, 1948. P. 51-52.

on which National will be paid throughout 1948, even though the particular flight might not carry a single pound of mail. This is the nearest approach to a direct subsidy for one of the larger domestic airlines that we have seen so far, and is quite similar to the subsidy being given to Northwest Airlines on its route via Alaska to Japan.

Year Ended December 31, 1947

	American Airlines	Eastern Air Lines	United Air Lines
Gross Revenues (000)	$81,731	$52,265	$69,038
Net Income (000)	(d) 2,963	1,259	(d) 3,774
Net Working Capital (000)	14,177	7,135	7,073
Debt (000)	40,000	5,000	32,660
Preferred Stock (000)	40,000	0	9,477
No. Shs. Common Stock	6,452,835	2,395,572	1,848,088
Net Per Share	(d) $0.68	$0.53	(d) $2.19
Dividend paid 1947	0	0.25	0
Price Range 1947-1948	11 3/8—7 1/4	24 1/4—16	28 1/2—16

(d) deficit

The Armed services have proposed to Congress that annual military plane building be boosted to $2,000,000,000 or more, compared with 1947 actual military output of $800,000,000. Advices from Washington indicate that this proposal, supported by the Finletter Commission report, has an excellent chance of Congressional approval in spite of the tendency of the present Congress to try to reduce government expenditures. Any large earnings for the aircraft manufacturing industry are, however, sometime away, as initial military orders will be primarily of an experimental nature and many months may elapse before the manufacturers begin to deliver new planes in substantial numbers. The decision on the part of government contracting authorities to permit adequate profits, up to a maximum of 15 per cent., on research and development contracts is, however, a strong indication that the earnings trend of the aircraft manufacturing industry will be upwards in later months of 1948, although no really good earnings for more than a few companies may be realised before 1949 or 1950.

The Douglas Aircraft Company report for the fiscal year ended November 30, 1947, illustrates the generally poor 1947 results of the aircraft manufacturing industry. The company reported sales of $128,000,000, on which losses before tax credits of nearly $15,000,000 were incurred. After carry-backs the company reported a net loss of $2,140,000, or $3.57 per share. Working capital, however, remained quite comfortable, amounting to $53,500,000, or after deduction of debt, approximately $81 per share on the common stock which is now selling at 62 in a range this year of 63 7/8—47 1/2. The company's backlog of $148,000,000 in January was, however, the lowest since before the War. Developmental and research work, which should eventually result in government contracts, is at a good level and is indicative of new business in prospect for which contracts should be signed in coming months.

A round-up of opinion in the aircraft manufacturing industry indicates that Boeing, North American, Consolidated Vultee and United Aircraft, which now have the bulk of current air force production contracts, are not likely to feel much of a let-down in production before the new procurement programme can get underway. Boeing, for example, has a leading position in the heavy bomber programme, with $250,000,000 or more in orders. North American, with over $200,000,000 in backlog orders, has a strong position in jet bomber contracts and design. A hundred of its B-45 four engined jet bombers have been ordered and the company is doing work for the Navy on jet planes ; and in guided missiles, a field where virtually every large plane builder also has a position. Consolidated Vultee is working on a contract for a hundred B-36 bombers, now being produced in quantity, and has a jet bomber design which the company hopes may result in a production contract. United Aircraft has $270,000,000 worth of backlog orders, of which the old reciprocating engine being delivered for the Boeing B-50 bombers and other planes is the most important item. The company is also tooling for production of jet engines and the Chance Vought Division is completing an order for Navy fighters and has additional contracts in prospect for Navy jet planes.

Aircraft manufacturing stocks have recovered materially from their lows of last summer and autumn. Recently, the advance may have proceeded further than immediate prospects justify, as no very substantial earnings can be forecast for the industry in 1948 and, furthermore, the protective provisions of the carry-backs law, which in many cases turned substantial operating losses into only minor net losses last year, no longer applies. The Treasury has indicated, however, that it would not oppose a permanent law permitting one-year carry-backs and five-year carry-forwards of losses by aircraft manufacturers.

Republic Aviation common stock at 11 1/4, in a range so far this year of 11 1/2—6 3/4, reported a loss of over $2,000,000 last year, or $2.11 per share on the common stock, after substantial tax carry-back credits. The company's book value and working capital, on the basis of preliminary estimates, are probably under $4 per share, after giving effect to the recent sale of its wholly-owned subsidiary, Air-cooled Motors, Inc., to Tucker Corporation for $1,800,000. The company's finances are somewhat strained and the stock is fully priced in contrast to many other aircraft manufacturing stocks still selling at large discounts from working capital and book values. However, Republic is busy on substantial government business which should last into 1949, and people close to the situation have been estimating good earnings for 1948. Talk of rearmament may have engendered more enthusiasm for some of these aircraft manufacturing stocks than immediate prospects for earnings and dividends warrant.

* * *

Following the sale by General Motors of its stockholdings in Bendix Aviation, an operation which was completed earlier in the year, there has been some discussion as to the possibility of General Motors selling its holdings in North American Aviation. Rumours are current to the effect that negotiations have been under way for the purchase of these holdings by Curtiss Wright. After thorough examination of the situation, however, it can now be assured that these rumours are not based on fact. The North American offering will probably be public.

Curtiss Wright reported a loss of about $1,365,000 for 1947, after a substantial tax carry-back and after transfer of nearly $1,000,000 from the reserve for contingencies. Net working capital at the year's end, however, exceeded $100,000,000. Curtiss Wright's subsidiary, Wright Aeronautical, managed to report a net profit of a little over $500,000 last year, although operating results showed a loss of over $2,000,000 and the profit resulted entirely from carry-back credits and transfers from reserves. Wright Aeronautical has recently announced a new combination of gas-turbine and conventional power plant, known as the "Turbo-Cyclone 18." The principle of this new engine is that the hot exhaust gases leaving the engine at high speed are channelled through three light-weight turbines mounted at the rear of the engine. Tests show such a combination boosts power by 20 per cent., or, conversely, reduces fuel consumption by 20 per cent., thus adding substantially to aircraft range.

The competitive position between various producers of aircraft engines may be changing. Since the War, United Aircraft has done the lion share of the conventional engine business. In jet engines there have been a number of new entrants. In combination engines such as the Curtiss Wright engine mentioned above, there is a new turbojet being produced by the Allison Division of General Motors. This

Allison turbojet has completed some 75,000 flying hours and many of the basic problems in early jet engine development have apparently been solved.

	Price December 31, 1947	Price April 5, 1948
American Airlines, Inc.	7 1/4	9 3/4
American Overseas Airlines, Inc.	5 1/8	6 1/2
Braniff Airways, Inc.	7 1/4	8 7/8
Delta Air Lines, Inc.	14 1/4	17
Eastern Air Lines, Inc.	18 5/8	20
National Airlines, Inc	8 1/2	9 1/8
Northwest Airlines, Inc.	11 7/8	16
Pan American Airways, Inc.	8 3/8	10
Transcont. & Western Air, Inc.	17 1/8	20 7/8
United Air Lines, Inc.	16 3/8	19 1/8
Western Air Lines, Inc.	6 3/8	7 1/2
Beech Aircraft Corp.	8	12 1/4
Bell Aircraft Corp.	17	18 1/4
Boeing Airplane Co.	23 5/8	27 1/2
Consolidated Vultee Aircraft Corp.	13 1/2	15 3/4
Curtiss-Wright Corp. (com.)	4 3/8	6 3/8
Douglas Aircraft Co.	47 1/2	61 3/8
Grumman Aircraft Engineering	32	39 1/8
Lockheed Aircraft Corp.	13 1/4	19 7/8
Glenn L. Martin Co.	14 3/8	20 5/8
North American Aviation	8	11 3/8
Republic Aviation Corp.	7 1/4	10 7/8
United Aircraft Corp.	23 5/8	28 5/8

April 5th, 1948.

Baker, Weeks & Harden.
Wall Street
(Jeremy C. Jenks.)

Official Bulletin of the F.A.I.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

Identity Card for Private Flyers.

With the progressive reanimation of international civil aviation, a question which had been solved before the War by the F. A. I., has arisen anew. It is of acute importance to private pilots flying either for pleasure or for business.

This question concerns the landing fees charged to private flyers by the majority of private or Government-owned aerodromes in different countries. Already high enough before the War, these fees, in view of the heavy costs now burdening aerodromes, have since grown to be a weighty obstacle to private flying, and are representing an ever-increasing share of the costs of international trips by private aeroplane. Besides this, the exchange difficulties prevailing in almost all the countries of the Old World, make it that the fees decreed for private aircraft landings in hard-currency areas are almost prohibitive to private pilots originating from less favoured countries. It cannot be denied that these factors turn the private aeroplane into a means of locomotion which, if not impracticable, is at least confined, from the international angle, to very few and privileged people.

As the facilitation of private flying is one of the main objectives of the F. A. I., it is therefore for this organisation to do all in its power to remedy this situation which, if allowed to continue, could incur serious consequences, not only for private aircraft owners, but also for the manufacturers of such aircraft.

It is worth recalling what the F. A. I. has so far undertaken in this direction, and the results it has achieved.

At its Conference in Cairo, at the end of 1933, the F. A. I. decided to ask all its members to negotiate with their Governments for the total suppression of landing fees for all private pilots possessing the F. A. I. Air Tourist Card. This Card was distributed by the various national aero clubs.

At the next Conference, held in 1934, in Washington, delegates had the pleasure of hearing an announcement by the Italian representative that, thanks to the efforts of the Reale Aero Club d'Italia, the Italian Government had agreed to abolish all landing fees for private aircraft, on condition that other countries provided reciprocal facilitations.

This decree served as pattern for those which were soon afterwards passed by several other governments, and by September, 1935, the F.A.I. was able to count ten countries in which the same advantages were provided reciprocally : Austria, Germany, Great Britain, Greece, Hungary, Italy, Japan, Poland, Roumania, Sweden.

A short time afterwards, Lithuania and Yugoslavia sent in their instruments of adhesion. Then, in 1936, it was the turn of Belgium and Luxembourg. In March, 1937, the fees were abolished in France, the Aero Club of France having decided to shoulder these costs itself. Around the same time, Czechoslovakia, Holland and Norway added their names to the list, whilst negotiations were on the point of succeeding in Switzerland.

In general, this system of Air Tourist Identity Cards worked very satisfactorily until September, 1939, when war broke out and destroyed the results of so much patient effort.

After 1946, however, the F.A.I. Air Touring Commission made it its primary duty to have those measures enforced again. At the present time, unfortunately, private flying between different countries is no longer so well organised as previously, and currency restrictions are rendering the problem still more complex.

Certain countries, like Great Britain, for instance, have already solved this difficulty from the national angle by re-establishing a private flying identity card giving access either to public aerodromes, or to private aerodromes, or to both.

It is of course desirable that countries should allow their private pilots a maximum of advantages on their own territory, and the F.A.I. cannot but very sincerely hope to see similar schemes to the British one, put into operation in the greatest possible number of countries. The greater the number of countries, the greater will be the number of private pilots, and the greater will be the need for an international convention enabling these pilots to move freely and easily beyond their frontiers.

It is such an international convention, in principle similar to the scheme in use before 1939, which constitutes today one of the principle objectives of the F.A.I. Without wishing to hide in any way the obstacles which have to be surmounted, the Air Touring Commission and the General Secretariat of the F.A.I. are pursuing these plans very energetically, and it is permissible to hope that, if a favourable echo is obtained from the competent authorities of the different countries, an encouraging amount of progress may be observed in the near future.

Meanwhile, however, as in many other domains, present-day difficulties manage to turn a relatively simple task into one requiring a great deal of patience and perseverance.

THE MONTH IN REVIEW

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FIRST FLIGHTS

● The prototype of the *SO 7010* twin-engined light transport made its first flight from Villacoublay airport on February 27th.

● The *Gloster "Meteor VII,"* two-seater trainer version of the Gloster "Meteor" twin-jet fighter, made its first flight on March 19th with S/Ldr. Waterton at the controls.

NEW AIRCRAFT

● The prototype of the *Avro T. I "Athena I"* three-seater trainer is currently being prepared for its initial flight tests at Woodford airport, Cheshire. The aircraft can be used for gunnery training, photography, bombing, and glider training, as well as for ordinary flying training.

● The *SO 6000 N-01*, prototype of the SNCA du Sud-Ouest SO 6000 single-jet experimental aircraft, has now been fitted with a Rolls-Royce "Nene" turbo-jet instead of the Junkers Jumo 004. It made its first flight in this form from Bricy airport, Orleans, on March 19th.

● The *Piper PA-15 "Vagabond"* is a new development of the Piper PA-11 "Cub" two-seater. The new model is in production and Piper Aircraft Corp. is able to market it at the remarkably low price of about $2,000. The *Piper PA-14 "Family Cruiser"* is a four-seater derived from the PA-12 "Super Cruiser" three-seater. Both the PA-14 and the PA-15 have been given C. A. A. type certification.

● The *Cierva W. 14 "Skeeter"* is a small two-seater helicopter which is being completed by Cierva Autogiro Co., Ltd. The new aircraft's gross weight is only 1,200 lbs.

● *Fairchild XC-120* is the designation of a twin-engined freighter with a detachable fuselage derived from the Fairchild C-82 "Packet." The new model resembles the "Packet" but is powered by two Pratt & Whitney R-4360 "Wasp Major" air-cooled 28-cylinder four-row radials of 3,300 H. P. The XC-120 is only in the blue-print stage at the present time.

● The Sikorsky Aircraft Division of United Aircraft Corp. has developed a new helicopter, the *Sikorsky XHJS-1*, under a Navy contract. The prototype has started its flight tests. Accommodating three to five occupants, the new model is powered by a Continental R-975-34 engine of 500 H. P.

Curtiss Wright XP-47 four-jet two-seater fighter taking off on its first flight.

Fiat G. 46-1 trainer and personal plane.

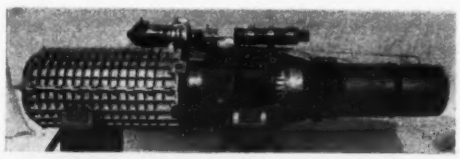
● Aeronautica d'Italia, the aircraft division of the Fiat concern, is bringing out two new versions of its Fiat G. 46 two-seater trainer and light aircraft : the *Fiat G.46-I* and the *Fiat G.46-II*. Both models are in production. The two types only differ in power plant : the G.46-I has an Alfa Romeo 155-Iter air-cooled six-cylinder in-line engine developing 205 H. P. for take off, whilst the G-46-II has a 250 H. P. de Havilland "Gipsy Queen 30" in-line engine.

● Panstwowe Zaklady Lotnicze P. Z. L., the nationalised Polish aircraft manufacturing concern, has completed the prototype of the *P. Z. L. S.1*, a trainer and light aircraft. It is a strut-braced high-wing monoplane of wooden construction : two-spar plywood-covered mainplane, fuselage partly fabric-covered, fixed tail-wheel landing gear. Power plant : Russian M 11F air-cooled five-cylinder radial of 140 H. P. take-off power. Span, 42 ft. 7 3/4 in. ; length, 27 ft. 10 3/4 in. ; wing area, 215 sq. ft. ; gross weight, 2,640 lbs. ; wing loading, 12 lb./sq.ft. ; maximum speed, 112 m. p. h.

POWER PLANTS

● Wright Aeronautical Corp. announces the *Wright "Cyclone C18CA,"* a new 2,700 H. P. version of the well-known "Cyclone 18" air-cooled twin-row radial. The engine has been developed under a Navy contract and bears the Navy designation Wright R-3350-26-W.

● *Wright Aeronautical Corp.* has taken over the design data and manufacturing rights for the *Menasco XJ-37* jet engine, by arrangement with the U S. A. F., which desired the transfer to speed up work on the project.



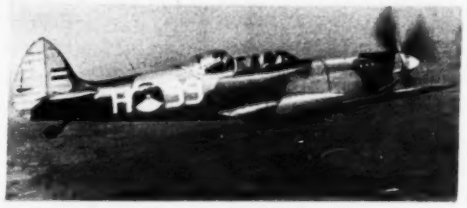
Lockheed-Menasco XJ-37 jet engine.

● The Blackburn "Cirrus Minor II" air-cooled four-cylinder in-line engine of 100 H. P. has now been approved for use with the de Havilland manually variable-pitch two-blade airscrews ; in this form it is designated *"Cirrus Minor D.503."* Take-off power, 98 H. P. at 2,500 r. p. m. ; maximum continuous power, 80 H. P. at 2,300 r. p. m. ; maximum economic cruising power, 75 H. P. at 2,200 r. p. m. All the above data are for performance at sea level.

INDUSTRIAL NEWS

● *Northrop Aircraft, Inc.*, has been awarded a $5,000,000 U. S. A. F. contract for 23 Northrop *C-125 "Raider"* transports, the military version of the Northrop N-23 "Pioneer" three-engined feeder transport.

● The *Dutch Air Force* has ordered an unspecified number of Vickers Supermarine "Spitfire" trainers. Delivery of these aircraft has already started.



Two-seater trainer version of "Spitfire."

INDUSTRIAL PERSONALITIES

● *Consolidated Vultee Aircraft Corp.* appointed a *Director of European Sales* on March 30th, in the person of *Georges de Sonchen*, whose headquarters will be at the Hotel Plaza-Athénée, 25 avenue Montaigne, Paris. For the past six months de Sonchen has been General Manager and Executive Vice-President of Aero-Transportes S. A., the Mexican airline. Prior to that he was Assistant European Operations Manager of Trans World Airline. As a war-time test pilot with Douglas Aircraft Co., he also assisted in the promotion of that company's foreign sales.

INTERNATIONAL ORGANISATIONS

● The IATA Government-Forms Sub-Committee, at its meeting in London last March, recommended the establishment of a number of *Free Zones*, to which passengers in transit would be able to pass without visa or passport for the country concerned. For cargo, the meeting called for more trade zones. The introduction of an *International Passenger Card* to replace normal passports for passengers is scheduled to be effected in certain countries about four months after the ICAO Facilitation Division meeting in Geneva in May. A single form has also been planned for private flyers, to cover the requirements of the Customs, health, post office and police authorities. Finally, a *Standard International Cargo Invoice* has been evolved, which requires a minimum amount of information.

● *ICAO Council* will open its 4th Session in Geneva on May 25th and on May 28th the *Legal Committee* will hold a meeting, also in Geneva.

● The joint financing through ICAO of the existing radio and navigational aids, communications and traffic control facilities, and meteorological services in Iceland by the nations whose airlines operate trans-Atlantic services will amount to $600,000 annually.

* Excerpts from Nos. 1436-1446 (March 11th to April 6th, 1948) of "Interavia, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four language editions, English, French, Spanish and German.

AIR TRANSPORTATION

INTERNATIONAL : *British Overseas Airways Corp.* started to operate to Japan at the end of March : it extended its Short "Solent" flying-boat route from Poole to Hong Kong via Augusta—Cairo—Bahrein—Karachi—Calcutta—Rangoon—Bangkok on to Iwakuni, near Kure in the British Commonwealth Zone of Occupation. The eventual terminal will be Tokio, where the service will complete a round-the-world service in conjunction with Northwest Airlines' route from the Orient to the United States. Since March 15th, *Northwest Airlines* has been offering a through service from the American capital to the Far East.

● *Trans World Airline* and *Peruvian International Airways* are arranging a scheme to fly European emigrants (mostly displaced persons) to Peru and Chile. Passengers will fly to New York via TWA and thence on to their destination by PIA.

● *Panair do Brasil* extended its weekly Lockheed "Constellation" service from Rio de Janeiro to Paris, from Paris to Frankfurt and from Rio to Buenos Aires, on March 25th.

● *Transportes Aeros Portugueses (TAP)* carried out a proving flight from Lisbon to Johannesburg in the middle of March.

● Following a proving flight to Bombay, the Czech state-owned airline *C. S. A.* has decided to open a Prague-Teheran service as an initial step towards a route to India.

● EUROPE : *Kastrup Airport, Copenhagen,* as the technical centre of the pooled Scandinavian airline services, will have 6,500 movements of SAS aircraft in the second quarter of 1948, against a total of 7,000 movements of all aircraft in the second quarter of 1947.

● For the resumption of the *German airmail service* to foreign destinations (which will probably take place in May), the Import & Export Office of the Anglo-American Occupational Zone has authorised a monthly grant of $50,000.

● On March 19th *KLM Royal Dutch Airlines* took delivery of the first of its seven Douglas DC-6 airliners at Douglas Aircraft Co.'s plant at Santa Monica, Calif., and flew the aircraft to Amsterdam.

● At the end of May the Belgian *SABENA* (S. A. Belge d'Exploitation de la Navigation Aérienne) will observe its twenty-fifth anniversary.

● Swissair plans to operate a daily Douglas DC-4 service from Zurich to London, following the opening of *Kloten Airport, Zurich.* Kloten is scheduled to be open to traffic on June 14th.

● *Civil aviation* and *private flying* are given allocations of 600,000,000 and 500,000,000 zloty (400 zloty =$1), respectively, in the *1948 Budget* approved by the *Polish Parliament.* It is stated that, with these credits, Polish civil aviation should be placed above its pre-war position. Moreover, the credits should enable private flying to be developed as a sport for the people.

● The *Soviet Russian airline route network* will have a total mileage of 1,37,000 by the end of the year, 28,000 miles more than was planned for the last year of the first post-war five-year plan (1950). Airlines in the Far East, Central Asia and local lines connecting outlying districts with the capitals of the Soviet Republics are undergoing special development.

● *Aeroflot,* the Russian airline, is stated to operate 100,000 aircraft-miles daily on scheduled services. By the end of 1949, the line's route network will be increased to 100,000 miles.

● ATLANTIC. The Italian Government has authorised *Linee Aree Transcontinentali Italiane (LATI),* the nationalised overseas airline, to develop and operate a route from Rome to Caracas (Venezuela) via Natal. SIAI-Marchetti S.M.95 four-engined airliners will be used.

● *Scandinavian Airlines System* hopes to introduce Douglas DC-6's on its North Atlantic route in July and the South Atlantic route in October. The North Atlantic service is to be intensified to seven round flights weekly on March 15th and the South Atlantic service to two round flights weekly shortly afterwards.

● On June 1st, *Pan American World Airways* will bring its summer timetable into force ; it schedules two round flights daily between New York and London, eleven weekly from the United States to Prague, ten weekly to Brussels and Frankfurt, and seven to Vienna. There will be four round flights weekly from New York to Lisbon and two from New York to Johannesburg.

● *Trans-Canada Airlines* gives July 1st as the date for the introduction of Canadair DC-4M2 four-engined airliners on its Montreal-Vancouver domestic route. At the same time TCA's trans-Atlantic service to London will be intensified to two round flights weekly ; moreover further intensifications are planned when the remainder of the line's twenty DC-4M2's are delivered.

● *British Overseas Airways Corp.* will intensify its trans-Atlantic schedules as follows on April 25th : London-New York service to six (instead of five) round flights weekly, London-Montreal three (instead of two) and New York-Bermuda four (instead of three).

● Trans-Atlantic air traffic in 1948 will be the heaviest on record, declares Edward S. Sullivan of TWA's trans-Continental Division. Bookings are four times greater than at the same time last year.

● *Air France* has moved into its New York office, at 683 Fifth Avenue (formerly known as the Dorothy Gray building). The thirteen-storey building houses the whole of the airline's North American business, sales and executive offices, as well as a main ticket and information office and departure station.

● On March 11th, Australian scheduled airlines completed two years of operations without any fatal accident. This, the longest fatality-free period in Australian air history, was achieved when civil aviation had attained its highest peak.

AIRLINE PERSONALITIES

● *Air Commodore H. G. Brackley* has been appointed *Chief Executive* and a member of the Board of Directors of *British South American Airways Corp.*, in succession to Air Vice-Marshall D. C. T. Bennett. Air Commodore Brackley served as Air Superintendent of Imperial Airways from 1924-1939. He was appointed Assistant to BOAC's Chairman (Special Duties) in 1945, in which capacity he organised the large-scale evacuation flights in India and Pakistan in the autumn of 1947.

SERVICE AVIATION

● France will start to build its first (15,000-ton) aircraft carrier this year. The new carrier will be equipped with SO 6000 two-seater jet fighters, a contract for which has just been placed with SNCA du Sud. The carrier and the aircraft should be completed at the same time.

● The Polish Air Force has a group of jet fighters, based at Sosnowiec.

● The *U. S. A. F. Strategic Air Command* observed its second anniversary in the fourth week of March. With headquarters at Andrews Air Force Base, near Washington, D. C., the long-range striking arm of the Air Force has a strength of some 45,000 officers and men, and eleven major bases within the United States. Regular training missions by B-29 "Superfortress" bombers of the 15th and 8th Air Forces, under Major General Leon W. Johnson and Roger M. Ramey, are undertaken to Europe, Japan, Hawaii, Alaska and the Caribbean.

● The *separation of the U. S. A. F. from the U. S. Army* is only about 35 per cent. complete. Under the Unification Act of July 25th, 1947, the separation is to be wholly completed before July 25th, 1949. The executive officer dealing with the separation hopes that the Air Force may be about 60 per cent. of the Army by July, 1948.

MILITARY PERSONALITIES

● *General Carl A. Spaatz,* Chief of Staff of the U. S. A. F., on April 1st announced his *resignation for July 1st. Lieutenant General Hoyt S. Vandenberg,* U. S. A. F. Vice-Chief of Staff, has been nominated as his successor by President Truman. — In his letter of resignation, General Spaatz states that he is retiring because he considers his mission "practically accomplished." General Spaatz is the U. S. A. F.'s first Chief of Staff and was previously Commanding General of the U. S. A. A. F. He had a distinguished record in World War II, notably in Europe where he commanded various United States Air Forces.

In the presence of W. Stuart Symington, Secretary of the Air Force, General Carl A. Spaatz greets Lieutenant General Hoyt S. Vandenberg, his successor as Chief of Staff of the U.S.A.F.

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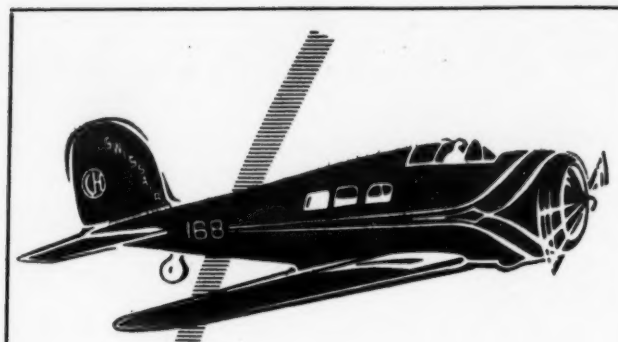

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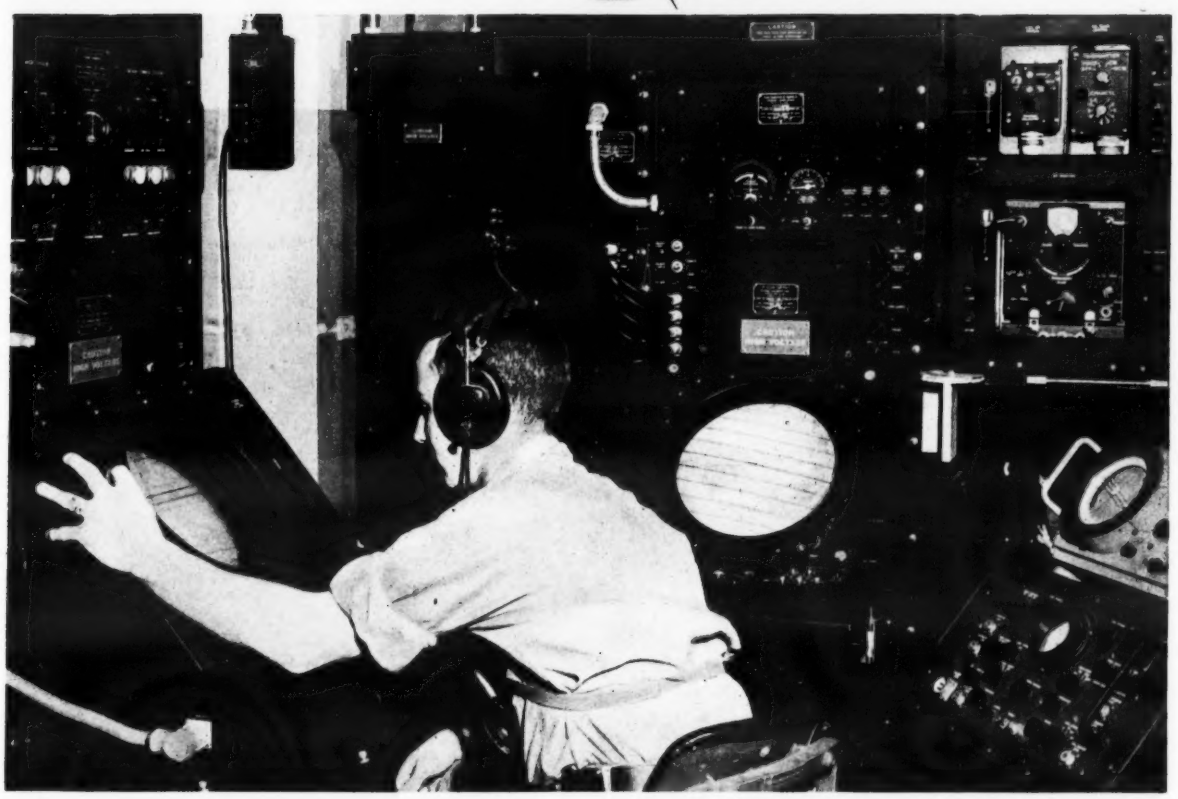

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